State of California

THE RESOURCES AGENCY

Department of Water Resources

BULLETIN No. 92

BRANSCOMB PROJECT INVESTIGATION

FEBRUARY 1965

HUGO FISHER
Administrator
The Resources Agency

EDMUND G. BROWN
Governor
State of California

WILLIAM E. WARNE
Director
Department of Water Resources

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PARTMENT OF WATER RESOURCES
. BOX 388
RAMENTO

WILLIAM E. WARNE, *Director*

October 21, 1964

Honorable Edmund G. Brown, Governor
and Members of the Legislature
of the State of California

Gentlemen:

I have the honor to transmit herewith the final edition of Bulletin No. 92, "Branscomb Project Investigation". The preparation of this report was conducted under Item 257 of the Budget Act of 1958-59 and subsequent appropriations.

Bulletin No. 92 summarizes the results of a study aimed at determining the engineering feasibility and economic justification of the proposed Branscomb Dam and Reservoir on the South Fork Eel River, as a water-associated recreation project.

Based on only those benefits susceptible to evaluation, the benefit-cost ratio of the Branscomb Project would be about 1.15 to 1.0; however, a complete project evaluation would require a monetary determination of fisheries benefits and detriments.

On April 1, 1964, the California Water Commission and the Department of Water Resources jointly held a public hearing on the preliminary edition of Bulletin No. 92 in Willits, California, to receive comments from interested persons and organizations. Comments received were given full consideration in the preparation of this final edition.

It is recommended that the Branscomb Project as described in the report not be authorized for construction at this time, but that additional studies be made of the fisheries and recreation benefits and detriments attributable to the project. In addition, as a result of comments received on the preliminary edition of the report, it is recommended that the Departments of Fish and Game, Parks and Recreation, and Water Resources make studies to fully evaluate, on a basin-wide development concept, alternative projects for the South Fork Eel River as to their potential for fisheries enhancement, recreation, and other uses.

Sincerely yours,

William E. Warne

Director

Enc.

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

EDMUND G. BROWN, Governor
HUGO FISHER, Administrator, The Resources Agency
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CALIFORNIA WATER COMMISSION

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NORRIS POULSON, La Jolla

-----O-----

WILLIAM M. CARAH
Executive Secretary

ORVILLE ABBOTT
Engineer

AUTHORIZATION FOR INVESTIGATION

The Branscomb Project was proposed in Bulletin No. 3, "The California Water Plan", May 1957. The California Water Plan presents a comprehensive master plan for the full practicable development of the water resources of the State to meet future needs for water for all purposes. In 1959, the Legislature adopted The California Water Plan as a general guide for the orderly and coordinated development and use of the water resources of the State.

Approval of Item 257 in the 1958-59 Budget Act made funds available for the Branscomb Project Investigation. Assembly House Resolution No. 296, June 1957, had authorized the Branscomb Project Investigation as follows:

> WHEREAS, Bulletin No. 3, The California Water Plan, lists the Branscomb Dam Project for fishery enhancement and recreational benefits to be accomplished by providing a minimum flow of 100 second-feet in the South Fork of the Eel River below the mouth of Rattlesnake Creek; and
>
> WHEREAS, The South Fork of the Eel River is particularly suitable for recreation development; however, low flows prevail during the summer season, and the water tends to stagnate in pools and temperatures often become intolerable to fish life; and
>
> WHEREAS, Branscomb Reservoir is designed to alleviate these unsatisfactory conditions; and
>
> WHEREAS, The Fish and Wildlife Service of the United States Department of the Interior in a preliminary report dated January 23, 1950, recommended that:
>
> (1) A broad plan, coordinating the many land uses in the project area be developed by interested federal and state agencies, the plan stipulates that:
>
> (a) All of the federally owned land in the project area be open to free use by the public, except for such portions as may be reserved by the planning agency for purposes of safety, efficient operation, or protection of public property;
>
> (b) Leases of land within the reservoir area stipulate the right of public access for the purpose of hunting, fishing, and other uncommercialized recreational use; now, therefore, be it

Resolved, That the Department of Water Resources is requested to expedite as a part of the California Water Development Program the investigation as to the engineering, economic and financial feasibility of a dam and reservoir in the Branscomb and alternate sites on the South Fork of the Eel River in Mendocino County; and be it further

Resolved, That the Department of Water Resources prepare at the earliest possible date a report of this investigation, which report will include the design of all important structures for the purpose of determining cost of construction, studies of areas receiving benefits from the project, cost benefit analysis, cost allocations and repayment plans, descriptions of land easements and rights of way, including relocation of roads and utilities, and such other information as is necessary to determine economic and financial feasibility to assist the Legislature in considering authorization of the project; and be it finally

Resolved, That a copy of this resolution be transmitted to Mr. Harvey O. Banks, Director of the Department of Water Resources.

ACKNOWLEDGMENT

Valuable assistance and data used in this investigation were contributed by agencies of the State and Federal Governments, Mendocino and Humboldt Counties, and private companies and individuals. This cooperation is gratefully acknowledged.

Special mention is made of the helpful cooperation of the following:

California Department of Fish and Game.
California Division of Highways.
California Department of Parks and Recreation.
Bureau of Reclamation, United States Department of the Interior.
Fish and Wildlife Service, United States Department of the Interior.
United States Corps of Engineers.

PUBLIC HEARING
BY
DEPARTMENT OF WATER RESOURCES
and the
CALIFORNIA WATER COMMISSION
on
Preliminary Edition
of
Bulletin No. 92, "Branscomb Project Investigation"
Held in Willits, California, on April 1, 1964

In accordance with the Water Code and the Department of Water Resources policy, the California Water Commission and the Department of Water Resources jointly held a public hearing on the preliminary edition of Bulletin No. 92, to receive comments from interested persons and organizations.

Sixty-one persons attended the hearing; many of them representing federal, state, and local governmental agencies as well as various organizations in the area. Several written comments were received, and the 17 persons listed below testified at the hearing:

Mr. Wayne Coy, representing Senator Petersen
Mr. Harvey Sawyer
Mr. V. M. (Bob) Moir
Mr. Mel Bareilles
Mr. Burton Banzhaf
Mr. Neil Remore
Mr. William George
Mr. Les Laughrey
Mr. Wayne Calder
Mr. Joe Scaramella
Mr. B. J. Vaughn
Mr. Bob Grundman
Mr. George McCammon
Mr. Otto von Seggern
Mrs. Waldo S. Cook
Mr. Glenn Carbrey
Mrs. Adah Blenn

Written comments were received from the following:

Mr. Otto C. von Seggern, Consulting Professional Engineer
Mrs. Edna R. Mitchell
Mr. Ned W. Mitchell
Mrs. Virginia M. Adams
Mr. Darrell K. Adams
Mr. Glenn J. Carbrey, President, Sportsmen's Council of the Redwood Empire
Mrs. Rose E. Wilson, Secretary, Laytonville Grange
Mr. Allen L. White, Chairman, Long Valley Farm Center
Senator Frank S. Petersen, Fourth Senatorial District
Mr. Lester E. Laughrey, President, North Mendocino County Chamber of Commerce
Mr. Burton Banzhaf, Legislative Representative, Ukiah Rod and Gun Club
Mr. Harvey Sawyers, Supervisor, Mendocino County
Mr. Melvin J. Bareilles, Supervisor, Humboldt County
Mr. Neil Remore, Secretary, Eel River Associated Sportsmen, Inc.
Mr. John J. Gray, Vice President, Union Lumber Company
Dr. Waldo S. Cook
Mr. Wayne Calder, Director, Salmon Unlimited

The following paragraphs briefly summarize the testimonies and written statements received.

With few exceptions, the chambers of commerce and sportsmen's organizations are in favor of the project. They feel that, with the area's lumber resource being depleted, development of the recreation resource will be the basis for most of the area's foreseeable economic growth; that since fish are an important part of the recreation resource, anything that helps the fish population would be economically beneficial to the area, and, that the recreation resource in general would be enhanced and would bring in many more people to this depressed area.

The sportsmen's organization taking exception to the project advanced opinions that it would be detrimental to fishlife; spawning grounds above the dam would be destroyed; the quality of water leaving the dam might not be advantageous to fishlife

downstream; and the dam might create a silt basin that would keep the river muddy or silty downstream.

Mr. Mel Bareilles, Supervisor of Humboldt County and Director of the Eel River Association, stated that although the Board of Supervisors of Humboldt County and everyone else would like to see the Branscomb Project constructed immediately, the Board would like to see a few alterations if possible. He mentioned some of the potential problems associated with the construction of Branscomb Project; such as the fluctuating water surface, the high water temperatures which would promote high algae growth, and the health problem created due to water contamination. He stated that in his opinion monies spent to construct the Branscomb Project could be put to a better use; such as a more comprehensive stream clearance program; more road-side camping and picnicking facilities along the major roads, a more recreational development on state and federal government owned lands; and the development of more information and enforcement to control the hazards of water pollution on the South Fork Eel River.

Mr. Burt Banzhaf, Director of the Eel River Association representing the Ukiah Rod and Gun Club, stated that his club took action to oppose the Branscomb Project on February 1963. Since that time nothing has developed that would make them change their opposition. He stated that it was their belief that this project would certainly be detrimental to fishlife.

Landowners that might be affected by the project were generally against it. Mr. B. J. Vaughn, representing the Union Lumber Company, stated that his company owns 12,800 acres

of timber land near the proposed project. They fear a land acquisition policy that would affect the sustained yield from their lands. Another owner of 15,000 acres near the proposed dam was concerned about increased property taxes. A question was also raised as to who would build and operate the recreational facilities.

Mr. Otto C. von Seggern, consulting engineer, gave a brief statement on a planning report which he has prepared as a proposal to the local interests of the area for further planning studies in the development of South Fork of the Eel River. His proposal is to study the engineering feasibility of constructing two or three storage reservoirs on the headwaters tributary to the South Fork and additional check dams along the South Fork between the proposed Branscomb Project site and its confluence with the main stem of the river.

Mr. George McCammon, representing the Department of Fish and Game, stated that since there is a great deal of controversy over the project's effect on fish and wildlife, a complete investigation should be made before the project is authorized.

Senator Frank S. Petersen (represented at the meeting by Mr. Wayne Coy) recommended that additional funds be budgeted for a study of this project by the Fish and Game Department and the Department of Parks and Recreation. If these departments are in favor of the project, he will submit a bill to the Legislature recommending it.

A review of verbal and written comments received indicates that the majority of local interests are in favor of the construction

of the Branscomb Project. However, as noted above there are a few exceptions. An office report setting forth all written comments received is on file with the Department of Water Resources in Sacramento.

The preliminary edition of Bulletin No. 92 recommended that the Department of Fish and Game study the effect the project would have on the fisheries of South Fork of Eel River; and that the Departments of Fish and Game, Parks and Recreation, and Water Resources of the Resources Agency of California jointly report on the feasibility of the project. In view of the comments on the proposed Branscomb Project received in response to the preliminary edition, the conclusions and recommendations in this final edition have been revised to reflect the belief that possible alternative projects for obtimum development of that basin should be studied prior to a final decision to authorize the Branscomb Project.

CHAPTER I. THE PROJECT AND THE BASIN

The Branscomb Project Investigation is a study of the engineering feasibility and partial economic justification of the construction of a dam and reservoir northwest of Branscomb on the South Fork Eel River.

This chapter discusses the purposes of that dam and reservoir, outlines the reasons for the selection of its proposed site on the South Fork Eel River and touches upon the development, history and economy of the basin whose waters drain into that river. Plate 1 shows the "Location of South Fork Eel River Basin".

Branscomb Project Investigation

The purpose of the proposed dam and reservoir is twofold: to maintain and possibly improve an existing fishery through control of water releases below the dam; and to increase recreation opportunities in the area by the improved stream conditions those releases create and by the addition of an easily reached reservoir suitable to water sports.

The creation of reservoir storage for water supply, flood control, and power production is not a purpose of the proposed dam. A Department of Water Resources reconnaissance survey in 1954 and United States Corps of Engineers studies in 1933 and 1950 (Appendix A: p, q) recommended that the Branscomb Project be restricted to the needs of recreation and fishery enhancement.

The objective of the Branscomb Investigation to determine and report on the engineering, economic, and financial feasibility of the Branscomb, or an alternative project, as set forth in the authorizing legislation, was necessarily limited to a study of engineering feasibility

and partial economic justification. Engineering studies were conducted to a degree sufficient to select the best alternative and to formulate and design the most desirable project for recreational purposes. Economic benefits were determined for projected recreational uses, but there remains a question as to the benefits or detriments associated with the effects of the proposed project on the Eel River fisheries.

As discussed later herein, complete economic justification could not be determined, since the Department of Fish and Game could only conduct a limited investigation. The department indicated that further investigation of project fisheries benefits and detriments would be required before a conclusive evaluation of the project could be made. The Department of Fish and Game report is included herein as Appendix C "An Amended Report on the Effect of the Branscomb Project on the Fishery of the South Fork Eel River". Furthermore, since no private nor public agency has expressed a desire during the investigation to undertake the construction and repayment of the costs of the project, no determination could be made of its financial feasibility.

The Department of Water Resources studied five possible sites for the proposed dam. Plate 2, entitled "South Fork Eel River Basin", shows locations of the dam sites considered.

The reservoirs at three of these sites--Hollow Tree, Rattlesnake and Elkhorn--would inundate existing spawning areas far below the proposed location of Branscomb Reservoir and would make difficult the access by salmon to upstream spawning areas. Steep canyon walls at each of these three proposed sites would limit reservoir recreation development. Furthermore, the water surface of such narrow reservoirs would lower rapidly with each water release. Rapid surface fluctuation hampers recreation enjoyment of

a reservoir. In addition, the capital expenditure for these three developments would exceed that for comparable storage at the proposed Branscomb site.

Reservoir fluctuation at the Branscomb site suggested by the U. S. Corps of Engineers for a point immediately downstream from Jack of Hearts Creek would have been moderate but, once again, capital expenditure for the project would exceed that for comparable storage at the site proposed by the Department of Water Resources. Furthermore, objections by the principal land owner blocked a complete investigation of the Corps site.

The Department of Water Resources therefore selected a site about one mile upstream from Jack of Hearts Creek for the proposed Branscomb Dam. The reservoir at this site would provide sufficient storage to meet South Fork Eel River flow requirements at the least capital expenditure.

The Branscomb Project as discussed herein, would be a reservoir with a storage capacity of 30,800 acre-feet and a surface area of 775 acres when filled to the spillway elevation. It would be created by a 126-foot high earthfill dam equipped with a fish ladder. Onshore recreation facilities would be installed in stages to meet the growth of recreation demand.

South Fork Eel River Basin

The South Fork Eel River Basin lies along the western slope of the Coast Range, and encompasses about 320 square miles in Humboldt County and about 380 square miles in Mendocino County. It extends in a northwest-southeast direction about 60 miles and has a maximum width of about 20 miles.

Basin Temperatures

During the period of record from March 1, 1903, through December 31, 1923, summer temperatures have reached a record high of 104 degrees Fahrenheit

in July and August. The average high has been 84 degrees in the same months. The winter temperature has dropped to a record low of 16 degrees in January. The average low has been 33 degrees. The average monthly temperature for the period of record has ranged from 66 degrees in August to 43 degrees in January.

Basin Development

In 1959, the estimated permanent population of the South Fork Eel River Basin was about 16,500. The average density of population was 25 persons a square mile.

The Redwood Highway (U.S. 101) enters the basin south of Laytonville, passes through Laytonville and moves northward, skirting Rattlesnake Creek to the creek junction with South Fork Eel River. From this point, the Redwood Highway follows the South Fork Eel River to the northern boundary of the basin.

East of the basin, the Northwestern Pacific Railroad follows the Eel River northward. This railroad serves Dos Rios, a settlement on the junction of Eel River and Middle Fork Eel River. From Dos Rios, a secondary road runs 12 miles west to Laytonville, continues another 13 miles west to Branscomb and then 10 miles further to De Haven on the Pacific Ocean. This is the Branscomb Road. Dos Rios and Laytonville are the closest towns to Branscomb, a cluster of houses and cabins occupied by the families of loggers. By way of the Redwood Highway and the Branscomb Road, Branscomb is 180 miles north of San Francisco and 130 miles south of Eureka.

Travelers in the 1870's reached the redwood area of the South Fork Eel River Basin over a single-lane wagon road. Cleared turnouts, spaced along the road at thousand foot intervals, permitted wagons to pass one another. Winter floods inundated the road. Winter landslides buried it. As late as 1913, most travelers between San Francisco and Eureka preferred to take a steamboat up the Pacific coast.

Pavement of the Redwood Highway began in the middle 1930's. Travel has increased rapidly since World War II. To meet this heavy use, the Division of Highways has improved several sections of the Redwood Highway to four-lane expressway standards. The Division of Highways plans to further improve the Redwood Highway. By 1970, the stretch from San Francisco to the redwoods will meet freeway standards, and the Branscomb Reservoir site and South Fork Eel River redwood region will be less than four hours by auto from metropolitan San Francisco.

Historians believe the Kato Indians, a tribe of about 1,000, were the original inhabitants of the Branscomb, Cahto and Laytonville Valleys in the headwaters of South Fork Eel River. In the 1850's, white settlers brought sheep and cattle into the valleys. The first use of water in this area was to irrigate grain which the settlers planted to feed their livestock. Mutton and beef from this livestock fed Trinity region gold miners. The settlers then built sawmills and used water to float redwood logs. Towns grew rapidly with the exploitation of mineral and forest resources and then, with the depletion of those resources, collapsed.

In the 1940's, the larger lumber mills began to expand. Newer methods of lumber processing enabled the larger mills to operate economically throughout a greater area. Small mills no longer dotted the basin with smoke plumes. The scattered mill towns which had been supported by those mills declined.

Basin Economy

Although water resources of the South Fork Eel River Basin in 1962 remain nearly as undeveloped as they were 100 years ago, the little water used for domestic, industrial, recreational and irrigation purposes is

essential to the economy of the basin. The economy depends first upon lumber, next upon recreation and last upon limited agriculture and the sand and gravel mines which supply local construction needs.

The forest products industry employs one out of four residents of the basin. The 1959 production capacity of the individual lumber mills ranged from 10,000 to 120,000 board-feet of lumber for each eight hour shift. Together, the mills produced an estimated one million board-feet of lumber a day and four million square feet of plywood a month.

The agriculture industry is not a significant part of the economy of the basin. Crops in the 1950's did not command high prices on available markets. Farmers raise stock and irrigate alfalfa fields in the small upland valleys. Although the irrigation of about 7,000 acres is ultimately possible, farmers in 1960 irrigated only an estimated 500 acres of the 450,000 acres in the basin. About 443,000 acres remain mountainous, nonirrigable forest, brush and grassland areas devoted to timber, recreation and cattle.

Tourists and sportsmen bring considerable business to Mendocino and Humboldt County residents. Resort lodges were the first private recreation developments in the South Fork Eel River Basin; cottage and camp units, trailer parks and motels followed. By 1957, private development provided about two-thirds of the overnight facilities available to vacationers.

About 24,000 acres of state park land lie in the South Fork Eel River Basin. Although the State has not extensively developed camp or picnic areas in existing park land remote from the Redwood Highway, it does develop park land adjacent to the highway as the Legislature makes funds available. Recreation planners estimate that public and private accommodations to serve about 5,000 overnight visitors existed within the basin in 1957.

Giant redwood groves, many of them public parks, help draw into the basin more than a million tourists a year. The Admiral W. Standley State Park, located 28 miles northeast of Fort Bragg and immediately adjacent to the site of the Branscomb Project, is one such park for the enjoyment of the redwoods.

In deer season, hunting is extensive and the kill is high, despite the hesitancy of landowners to allow unlimited access to their lands. They hesitate because fire hazard throughout dry brush and forest areas is extreme.

The migration of salmon and steelhead to South Fork Eel River spawning grounds attracts fishermen. Ready access along the greater part of the river and available overnight accommodations encourage wintertime fishing for steelhead. In summer and fall, however, at the very peak of the recreation period, South Fork Eel River water runs at its lowest and warmest. Both conditions adversely affect the salmon, steelhead and resident trout fishery.

CHAPTER II. WATER SUPPLY AND WATER USE

Coast Range canyons and low mountains corrugate the South Fork Eel River Basin. Some ridges exceed 4,000 feet in elevation, but most rise only to about 3,000 feet. The major canyons drain to the northwest, dropping from an elevation of 1,500 feet to the sea. This chapter discusses the precipitation which falls into the basin, the runoff which the canyons and ridges channel toward the sea, and the uses to which that runoff is put.

Water Supply

For purposes of evaluating precipitation and runoff in the South Fork Eel River Basin, a 36-year base period extending from 1920-21 through 1955-56 was selected. This period, which includes a series of wet years and a series of dry years, closely approximates mean water supply conditions within the South Fork Eel River Basin. Moreover, sufficient hydrologic data were available during that period. The 50-year mean period from 1905-06 through 1954-55 was selected to represent long term water supply characteristics of the basin.

Precipitation

Annual depth of precipitation in the South Fork Eel River Basin, as recorded at Precipitation Station Branscomb 5 North, ranges from a recorded maximum of 132.62 inches in 1903-04 to a minimum of 46.12 inches in 1919-20. The average annual precipitation at this station for the period of record (July 1, 1900, through June 30, 1956) is 78.65 inches. The annual depth of precipitation has ranged from 173 percent to 60 percent of this average.

Sweeping south from the Gulf of Alaska, polar air masses create the storm fronts responsible for most of the winter storms which strike the South Fork Eel River Basin from October through April. Warmer air masses associated with more severe basin storms originate further south than the Gulf of Alaska. Because of their warmth, these air masses generally carry considerably more moisture than do the polar air masses. The heavy, resultant rains are those which most often severely flood the land. Infrequent thunderstorms during the dry summers account for only about five percent of the annual basin precipitation.

Annual winter snowfall at Branscomb from 1904 to 1923 ranged from one inch to 44 inches and averaged about 22 inches. Snowfall melts rapidly and does not appreciably retard runoff. Far more rain than snow falls during the wet, winter months.

Precipitation Stations and Records. From the many precipitation stations in the South Fork Eel River Basin, four were selected which best show precipitation characteristics in the area near the proposed Branscomb Dam. These are the Branscomb 5 North, Laytonville 3 Southwest, Cummings and Standish Hickey State Park precipitation stations. Plate 2, entitled "South Fork Eel River Basin", shows the locations of these stations. Additional precipitation stations were selected at Fort Bragg, Dos Rios and Covelo. Although they lie beyond the basin boundary, these three stations fairly represent areal precipitation. Plate 2 also shows the general precipitation pattern throughout the basin by means of isohyetal lines of mean annual precipitation. An isohyet is a line along whose path equal precipitation falls.

Table 1 lists the locations and periods of record of the seven selected precipitation stations and the maximum and minimum depths of precipitation recorded at each. Table 2 shows recorded and estimated annual precipitation at the Branscomb 5 North Precipitation Station for the period from July 1, 1900, through June 30, 1956. Table 3 shows monthly distribution of annual precipitation, as represented by recorded precipitation at the Branscomb 5 North station for the 23-year period from July 1, 1933, through June 30, 1956.

To evaluate the water supply available for regulation in Branscomb Reservoir, average annual depth of precipitation for the drainage area above the Branscomb dam site was estimated. Plate 2 delineates this drainage area boundary. The estimated average annual depth of precipitation on land within this boundary is 68 inches.

To determine reservoir water releases necessary to best maintain the river fishery, estimates were made of the average annual depth of precipitation for a second drainage area below the proposed Branscomb Dam, as delineated on Plate 2. This drainage area lies above a selected downstream point of stream flow control and excludes the drainage area above the Branscomb dam site. The estimated average annual depth of precipitation on land within this boundary is 69 inches.

The selected point of stream flow control, also shown on Plate 2, lies about 12 miles downstream from the Branscomb dam site and immediately below the junction of Rattlesnake Creek with South Fork Eel River. The principal fishing and recreation areas lie below this point. Upstream from this point, the South Fork Eel River remains relatively inaccessible to a point two miles below the Branscomb dam site.

TABLE 1

PRECIPITATION STATIONS IN OR NEAR SOUTH FORK EEL RIVER BASIN

Station	Elevation, in feet	Latitude and longitude	Period of Record: Years	Depth of precipitation, inches: Average	Maximum	Minimum	Source[a/]
Basin:							
[illegible] North	1,500	39° 39' 123° 37'	1900-01 through 1955-56[b/]	72.65	132.62	46.12	USWB
Laytonville 3 Southwest	1,[illegible]	39° 42' 123° 29'	1917-18 through 1956-57	72.28	135.02	34.27	USWB
Cummings	1,[illegible]	39° 50' 123° 35'	1921-[illegible] through 1959-60	70.14	113.92	45.30	USWB
Standish Hickey State Park	850	39° 52' 123° 44'	1950-51 through 1959-60	[illegible].30	149.87	53.68	CDBP
Near basin:							
Fort Bragg	80	39° 27' 123° 4[illegible]'	189[illegible]-[illegible] through 1958-59	39.25	[illegible].79	17.81	USWB
Dos Rios	927	39° 43' 123° 21'	1920-21 through 1959-60	45.09	90.07	17.79	USWB
Covelo	1,385	39° 50' 123° 05'	1861-62 through 1959-60[c/]	36.18	72.60	16.06	USWB

a/ USWB: United States Weather Bureau.
CDBP: California Division of Beaches and Parks.
b/ Broken record: Eight precipitation years (July 1, 1923, through June 30, 1931) are estimates.
c/ Broken record.

TABLE 2

RECORDED AND ESTIMATED ANNUAL PRECIPITATION AT
THE BRANSCOMB 5 NORTH STATION

(In inches)

Precipitation year	Precipitation	Index[a]	Precipitation year	Precipitation	Index[a]
1900-01	84.86	1.15	1930-31	54.21[d]	.71
02	101.00	1.32	32	64.99	.85
03	89.07	1.16	33	64.33	.84
04	132.62[b]	1.73	34	55.47	.72
05	72.62	.95	35	67.45	.88
1905-06	90.80	1.18	1935-36	93.54	1.21
07	101.09	1.33	37	56.08	.73
08	66.86	.87	38	118.57	1.54
09	111.09	1.44	39	58.28	.76
10	76.84	1.00	40	97.57	1.27
1910-11	70.22	.91	1940-41	98.15	1.28
12	67.95	.88	42	91.65	1.19
13	84.54	1.10	43	82.57	1.07
14	97.90	1.27	44	54.94	.71
15	98.01	1.27	45	73.52	.96
1915-16	88.39	1.14	1945-46	82.17	1.07
17	75.49	.98	47	54.46	.71
18	58.51	.76	48	76.91	1.00
19	71.50	.93	49	69.28	.90
20	46.12[c]	.60	50	66.93	.87
1920-21	104.23	1.35	1950-51	99.58	1.30
22	59.33	.77	52	102.90	1.33
23	52.13	.68	53	97.90	1.28
24	40.85[d]	.53	54	93.78	1.22
25	90.75[d]	1.18	55	57.90	.75
1925-26	61.41[d]	.80	1955-56	114.15	1.49
27	95.88[d]	1.25			
28	72.03[d]	.94			
29	54.37[d]	.71			
30	71.14[d]	.93			

a/ Ratio of annual precipitation to mean annual precipitation.
b/ Maximum of record.
c/ Minimum of record.
d/ Estimated.

NOTE:
Average annual precipitation for period of record (July 1, 1900,through June 30, 1956) is 78.65 inches.

Mean annual precipitation for the 50-year mean period (July 1, 1905,through June 30,1955) is 76.91 inches.

TABLE 3

AVERAGE MONTHLY DISTRIBUTION OF
RECORDED PRECIPITATION AT
STATION BRANSCOMB 5 NORTH

(For period 1933-34 through 1955-56)

Month	Precipitation, in inches	Percent of annual total
January	16.50	20.5
February	11.81	14.7
March	10.45	13.0
April	4.97	6.2
May	3.03	3.8
June	1.18	1.5
July	0.06	0.1
August	0.13	0.2
September	0.65	0.8
October	5.57	6.9
November	9.68	12.0
December	16.31	20.3
TOTAL	80.34	100.0

Both a Department of Water Resources report in 1957 (Appendix A: d) and a United States Department of the Interior report in 1950 (Appendix A: i) suggested this point of stream flow control. It is a point past which waters of the South Fork Eel River must flow at a specified rate in order to best maintain the river fishery. Releases from the proposed Branscomb Dam would maintain this specified flow during dry periods.

Runoff

As estimated and recorded at the Branscomb stream gaging station, annual runoff in the South Fork Eel River Basin during the 36-year base period ranged from a maximum of 230,000 acre-feet in 1937-38 to a minimum of 24,000 acre-feet in 1923-24, and averaged 110,100 acre-feet. Annual runoff thus ranges from 209 percent to 22 percent of average.

Average annual runoff at Miranda stream gaging station for the 36-year base period is estimated to be 1,153,000 acre-feet. This compares with an estimated mean annual runoff of 1,160,000 acre-feet for the 50-year mean period.

Stream Gaging Stations and Records. Branscomb and Miranda stream gaging stations on the South Fork Eel River were selected to show runoff characteristics near the proposed Branscomb Dam. Plate 2 shows the locations of these two stations. Because records at the Branscomb and Miranda stream gaging stations begin in October 1946 and May 1940, respectively, it was necessary to estimate earlier runoff by correlation with recorded runoff of the Eel River at the Van Arsdale Dam and Scotia stations.

Table 4 lists the locations and periods of record of the four selected stream gaging stations and the average, maximum and minimum rates of flow recorded at each. The U. S. Geological Survey annually publishes records of stream flow at these stations (Appendix A: n).

Both Plate 3, entitled "Annual Runoff at Branscomb Stream Gaging Station, South Fork Eel River", and Table 5 show estimated and recorded runoff at the Branscomb station. Table 5 also shows estimated runoff from the drainage area between the Branscomb dam site and the downstream point of stream flow control. In addition, it shows estimated runoff from the drainage area above the Branscomb dam site. This area occupies six percent of the total area of the South Fork Eel River Basin and discharges seven percent of the total basin runoff. Little impaired by the activities of man, it closely approaches natural runoff.

Table 6 shows monthly distribution of annual runoff as represented by recorded runoff of the South Fork Eel River at the Branscomb and Miranda stream gaging stations for the 11-year period from 1946-47 through 1956-57.

TABLE 4

STREAM GAGING STATIONS IN OR NEAR SOUTH FORK EEL RIVER BASIN

Station	Elevation, in feet	Latitude and longitude	Period of record: Years	Rate of flow in second-feet: Average	Maximum	Minimum	Source [a]	Drainage area in square miles
In basin:								
South Fork Eel River near Branscomb	1,380	39° 43' 123° 39'	1946-47 through 1958-59	176	20,100	1.4	USGS	43.9
South Fork Eel River near Miranda	250	40° 10' 123° 46'	1940-41 through 1958-59	1,843	173,000	9	USGS	537
Near basin:								
Eel River at Van Arsdale Dam	1,400	39° 23' 123° 06'	1922-23 through 1925-26; 1927-28 through 1958-59	597	48,600	0	USGS	347
Eel River at Scotia	36.15	40° 29' 124° 05'	1911-12 through 1913-14; 1916-17 through 1958-59	6,821	541,000	10	USGS	3,113

a/ USGS: United States Geological Survey.

TABLE 5

RECORDED AND ESTIMATED ANNUAL RUNOFF OF SOUTH FORK EEL RIVER
(In acre-feet)

Runoff year	At Branscomb stream gaging station: Runoff	Index [a]	At Branscomb dam site: Estimated runoff	At point of stream flow control less runoff at Branscomb dam site: Estimated runoff
1920-21	178,000[b]	1.62	171,000	430,000
22	79,000	.72	76,000	188,000
23	61,000	.55	60,000	136,000
24	24,000	.22	25,000	56,000
25	151,000	1.38	146,000	394,000
1925-26	71,000	.64	69,000	185,000
27	167,000	1.52	161,000	423,000
28	100,000	.91	96,000	250,000
29	45,000	.41	45,000	109,000
30	77,000	.70	74,000	194,000
1930-31	40,000	.37	38,000	145,000
32	81,000	.73	79,000	202,000
33	79,000	.72	76,000	203,000
34	57,000	.52	55,000	142,000
35	112,000	1.02	108,000	279,000
1935-36	122,000	1.11	118,000	319,000
37	75,000	.68	72,000	195,000
38	230,000	2.09	218,000	581,000
39	63,000	.57	61,000	157,000
40	150,000	1.36	143,000	396,000
1940-41	168,000	1.53	161,000	401,000
42	152,000	1.38	147,000	403,000
43	125,000	1.13	120,000	321,000
44	51,000	.47	50,000	129,000
45	106,000	.97	103,000	264,000
1945-46	138,000	1.26	133,000	338,000
47	53,800[c]	.49	52,000	136,000
48	106,400	.97	102,000	263,000
49	101,200	.92	97,000	254,000
50	96,000	.87	92,000	229,000
1950-51	162,000	1.47	153,000	425,000
52	167,200	1.52	159,000	422,000
53	158,100	1.44	152,000	409,000
54	151,500	1.38	143,000	395,000
55	65,300	.59	63,000	175,000
1955-56	199,400	1.81	191,000	519,000
TOTAL	3,963,000		3,809,000	10,067,000
Average	110,100		105,800	279,700

a/ Ratio of annual runoff to average annual runoff.
b/ Estimates begin here.
c/ Records begin here.

TABLE 6

AVERAGE MONTHLY DISTRIBUTION OF
RECORDED RUNOFF AT
BRANSCOMB AND MIRANDA STATIONS

(For period 1946-47 through 1956-57)

Month	Branscomb		Miranda	
	Runoff, in acre-feet	Percent of annual total	Runoff, in acre-feet	Percent of annual total
January	35,500	28.5	367,000	28.2
February	19,900	16.0	218,000	16.8
March	19,400	15.6	206,000	15.8
April	9,070	7.3	99,600	7.7
May	4,920	4.0	48,700	3.8
June	1,810	1.5	18,700	1.4
July	700	0.6	7,900	0.6
August	340	0.3	4,200	0.3
September	260	0.2	3,600	0.3
October	2,230	1.8	26,200	2.0
November	6,370	5.1	58,100	4.5
December	23,800	19.1	242,000	18.6
TOTAL	124,300	100.0	1,300,000	100.0

Water Use

Direct diversion and use of water from streams within the South Fork Eel River Basin is small. Not even in critically dry seasons does the diversion of water for domestic and agricultural purposes materially reduce the amount of summer runoff. Water is neither imported to nor exported from the South Fork Eel River Basin.

Applications to Appropriate Water

Since December 19, 1914, the effective date of the Water Commission Act, residents of the South Fork Eel River Basin have filed, with the State Water Rights Board or its predecessor agencies, 52 applications to appropriate water from the South Fork Eel River and its tributaries. Appendix D to this bulletin presents pertinent information with respect to each of these applications. The 52 applications represent a total diversion of about 24 second-feet.

Cedar Creek Fish Hatchery

The Department of Fish and Game Cedar Creek Fish Hatchery diverts 12 second-feet of water for use in the rearing of trout. The hatchery lies at the junction of Cedar Creek with the South Fork Eel River and about three miles below the selected point of stream flow control. Each year hatchery workers raise about 350,000 salmon and trout fingerlings for release into coastal streams to supplement natural production.

Water Service Agencies

Use of water by seven major water service agencies within the South Fork Eel River Basin totals about one second-foot. These agencies obtain water both by surface diversion and by collector systems which pump water from the deep, saturated gravels of stream beds. In 1959 the largest of these agencies, the Redway Water Company, had 400 service connections. The other water agencies and their 1959 service connections are: the Garberville Water Company, Incorporated, 320; the Weott Water Works, 150; the Meyers Water Works of Meyers Flat, 80; the Miranda Water Company, 51; the Phillipsville Water System, 35; and the Benbow Hotel Company of Benbow, 30. Records, as transcribed in Appendix B, show that neither the Weott Water Works nor the Miranda Water Company has applied to appropriate water from the South Fork Eel River.

Other Water Uses

Domestic, industrial, recreation, and irrigation purposes utilize the remaining 11 second-feet for which residents of the South Fork Eel River Basin have filed applications to appropriate water.

CHAPTER III. RECREATION USE OF THE BRANSCOMB PROJECT

Chapter I states the twofold purpose of the Branscomb Project:

- to maintain and possibly improve an existing fishery through control of water releases below the dam; and

- to increase recreation opportunities in the area by the improved stream conditions those releases create and by the addition of an easily reached reservoir suitable to water sports.

This chapter discusses that twofold purpose. It describes the effects of the quality, quantity, and temperature of the water on the existing fishery of the South Fork Eel River, notes the fishery and recreation benefits of the minimum stream flow which proposed water releases from Branscomb Reservoir would maintain in the South Fork Eel River, outlines a schedule for the construction of recreation facilities bordering the proposed reservoir, and estimates the annual dollar value of those recreation facilities.

Stream Recreation

The years 1947 and 1957 are those of the greatest and smallest estimated salmon migrations into the stream system of the South Fork Eel River. In 1947, an estimated 175,000 king and silver salmon left the Pacific Ocean, battled Eel River currents and returned instinctively into the South Fork Eel River to spawn in their native basin waters and then to die. Ten years later, only an estimated 32,000 salmon completed a similar migration.

Fish Count

Since 1938, upstream migrations of king and silver salmon and steelhead trout past the Benbow Dam fish ladder have been counted. Tabulations of the annual fish counts at Benbow Dam from the 1938-39 through the 1958-59 spawning seasons are included in Appendix C to this bulletin. Table 1 in Appendix C indicates a continuing decline in the number of salmon passing Benbow Dam during the past decade. About two-fifths of the total length of the South Fork Eel River lies downstream from Benbow Dam. Salmon which spawn in these downstream waters remain uncounted.

Fish Catch

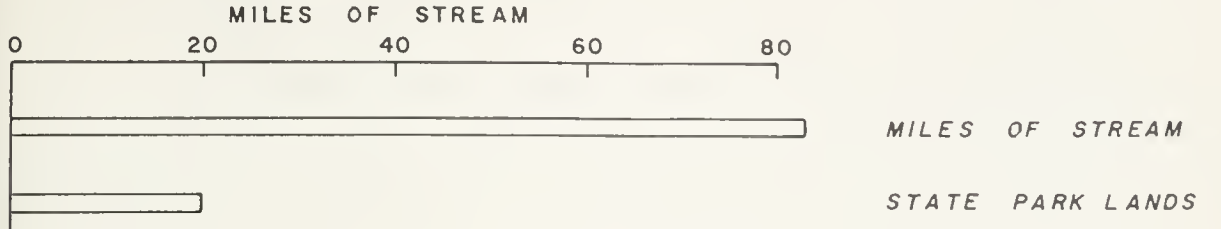
Figure 1, "Streamside Recreation Access", shows the extent of public access to fishing, swimming, picnicking and camping areas of the South Fork Eel River below the proposed Branscomb Dam. These areas were classified with respect to their accessibility after identifying their public or private ownership. Extensive streamside recreation requires easy access. The South Fork Eel River has such access.

Drifting slowly down the lower South Fork Eel River in boats, fishermen normally catch their first salmon in August. During November, bank fishermen follow the concurrent upstream migrations of salmon and steelhead trout. High and muddy river waters reduce and sometimes curtail winter fishing for many days. On good days, however, fishermen crowd easily reached fishing areas below Benbow Dam.

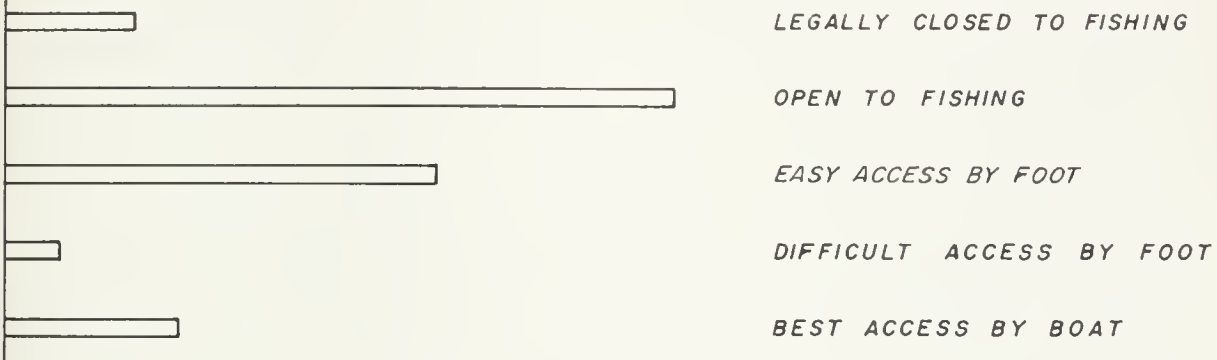
Estimates derived from the U. S. Fish and Wildlife Service fishing season census from 1956 through 1959 indicate that sport fishermen annually catch about 500 salmon, 2,200 steelhead trout and 17,400

STREAMSIDE RECREATION ACCESS

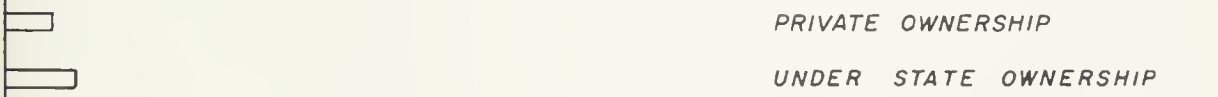
BRANSCOMB DAM TO JUNCTION, SOUTH FORK EEL AND EEL RIVERS



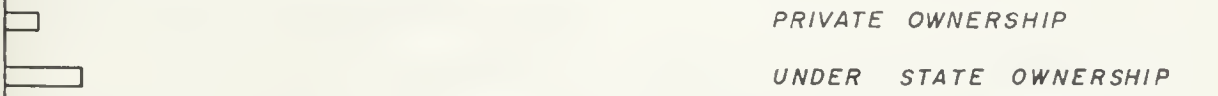
FISHING ACCESS



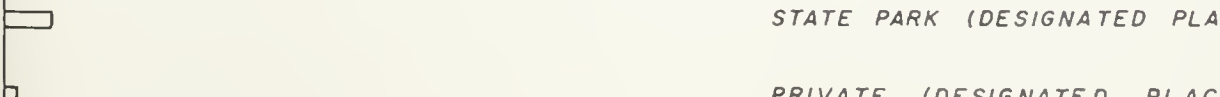
SWIMMING ACCESS



PICNICKING ACCESS



CAMPING ACCESS



"resident trout" in the South Fork Eel River. The Department of Fish and Game states that the majority of such "resident trout" most probably are young steelhead and silver salmon.

The use of a fishing area by one fisherman for any portion of a day is one angler-day. The fishing season census shows that fishermen annually spend an average of 1,000 angler-days to fish for salmon, 5,000 to fish for steelhead trout and 11,600 to fish for "resident trout".

Water Quality as Related to Fishery

The Department of Fish and Game recommends consideration of several factors in the determination of water quality suitable to the successful propagation and maintenance of fish and aquatic life. Among these factors are the dissolved oxygen content, hydrogen-ion concentration and range of conductivity.

The recommendations state that the dissolved oxygen content of stream waters should drop no lower than 85 percent of saturation. Analysis of monthly samples obtained at Miranda indicated the dissolved oxygen content of South Fork Eel River waters to be generally satisfactory.

The recommendations also state that the hydrogen-ion concentration of stream waters should remain between 7.0 and 8.5. Hydrogen-ion concentrations of less than 7.0 reflect acidic waters; those greater than 7.0 reflect alkaline waters. The hydrogen-ion concentration of the South Fork Eel River ranges from a slightly acidic 6.4 to a slightly alkaline 8.2 and averages slightly above 7.0.

Finally, the recommendations suggest that specific electrical conductance at 77 degrees Fahrenheit should range between 150 and 500

micromhos and that conductance generally should not exceed 1,000 micromhos. A micromho measures ease of specific electrical conductance. A high specific electrical conductance indicates a heavy mineral content; a low specific electrical conductance indicates a low mineral content. Water containing neither too many nor too few minerals best supports the fishery. Specific electrical conductance of South Fork Eel River waters at 77 degrees Fahrenheit varies from 76 to 270 micromhos, averages about 170 micromhos, and is acceptable for any type of fishery. Analysis of water samples from the South Fork Eel River Basin showed that mineral salts highly toxic to aquatic life exist only in low concentrations and have no effect on the present fishery.

Water Temperature

Temperature profoundly influences the propagation, development and survival of king and silver salmon and steelhead trout. It is believed that temperature physiologically triggers the spawning activities of salmon and trout. Temperature also controls the growth of the tiny water plants and animals which serve to feed young salmon. Large amounts of green algae grow in summer waters of the South Fork Eel River. Water temperature above 60 degrees Fahrenheit promote the growth of such algae and the minute aquatic organisms which live in and on the algae. Until they become intolerable to the fish, such temperatures benefit the fishery.

Experiments by J. R. Brett (Appendix A: r) have shown that death to king and silver salmon results under indefinite exposure to water temperatures higher than 76 degrees or lower than 44 degrees Fahrenheit. Fatalities under such conditions prevail especially among the young salmon. These experiments show that 50 percent of the young Pacific salmon subjected

to water temperatures of 77 degrees Fahrenheit die within 20 hours; at 81 degrees Fahrenheit, 50 percent die within two hours. The experiments prove that young Pacific salmon prefer water temperatures between 54 and 58 degrees Fahrenheit.

Plate 4, entitled "Temperature Tolerances of Young Salmon and Observed Stream Temperatures", depicts these tolerances graphically against the maximum and minimum stream temperatures for a one-year period as recorded in the South Fork Eel River near Branscomb and at Benbow Dam, and in the Eel River estuarine waters near Fernbridge. Estuarine waters are those waters where incoming tides meet descending river currents. These records show that, along the major portion of the South Fork Eel River, temperatures necessary to salmon survival generally occur between October 1 and April 30, the period of salmon migration.

Sometimes, however, low water conditions during the fall season delay upstream migrations from estuarine waters. In addition, late spring and early summer warm water conditions sometimes create a thermal block which delays the downstream migration of fingerlings to the sea and temporarily forces them to remain in the cool, spring fed tributaries of the South Fork Eel River headwaters.

Effects of Releases of Stored Water

Increased flows in the South Fork Eel River can minimize delays in upstream and downstream migrations by improving water temperature conditions for salmon. Lower water temperatures along a portion of South Fork Eel River would alleviate the deteriorating effect of higher water temperatures elsewhere and thus benefit the fishery. Water releases from

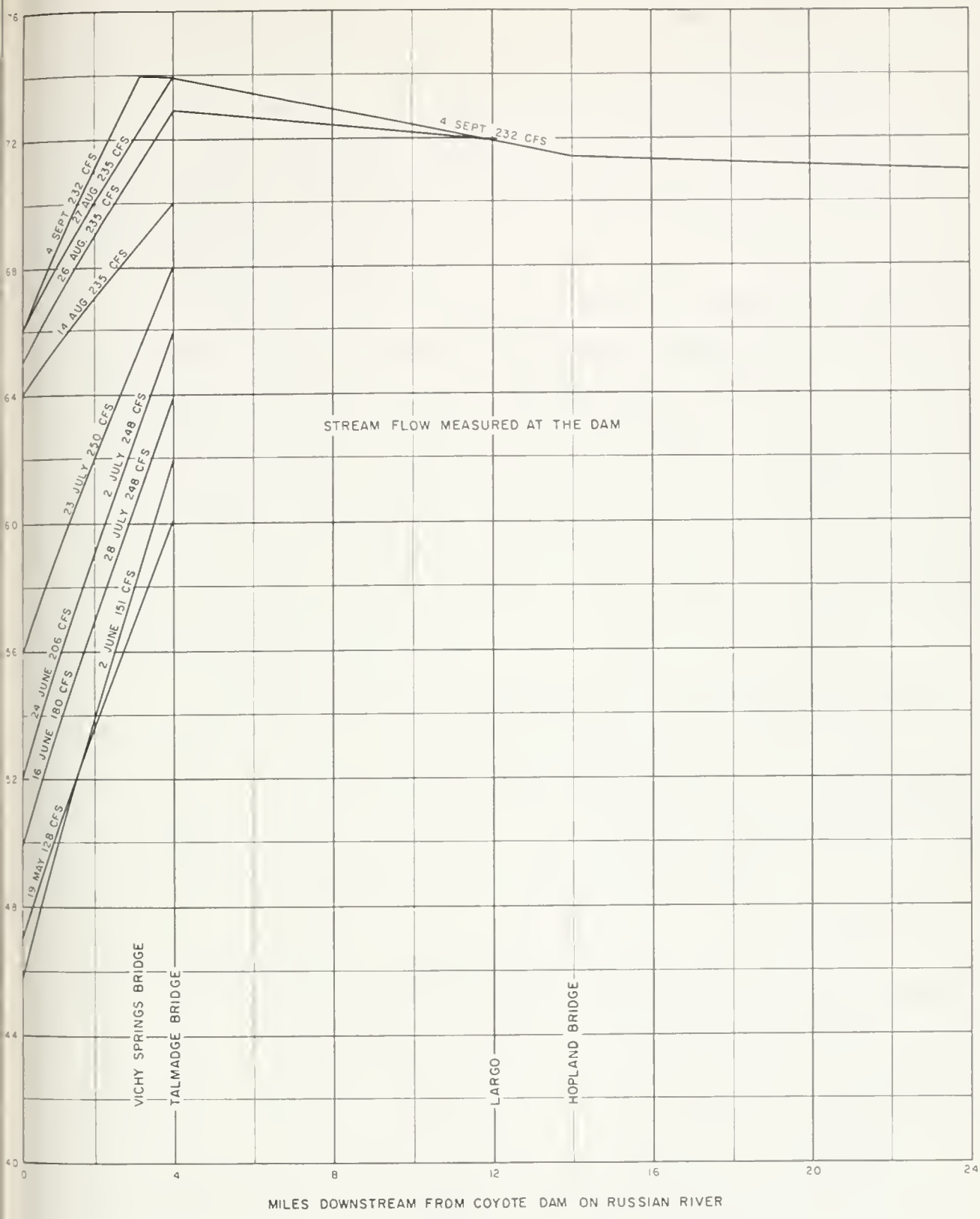
the proposed Branscomb Reservoir would reduce summer temperatures in the South Fork Eel River below the dam for a distance of about 10 miles. The Department of Fish and Game reached this conclusion after a study in 1959 of summer water temperatures and stream flow of the Russian River below Coyote Valley Dam. The character and climate of the area along the river below this dam approximates that of the area along the South Fork Eel River below the proposed Branscomb Dam. Figure 2 shows "Russian River Temperature Change Below Coyote Dam".

Increased flows in the South Fork Eel River would encourage early spawning and enlarge spawning areas. In years when runoff drops below average, water releases from the proposed Branscomb Reservoir would allow entrance into the river of early spawning king salmon. Both then and in years of average runoff, such releases would inundate additional gravels and thus increase spawning areas for the salmon and add to spawning success.

Increased flows in the South Fork Eel River would also extend the fishing season. Because water releases from the proposed Branscomb Reservoir would attract early spawning king salmon and steelhead trout, more fish would inhabit the river for a longer period of time.

Production of the tiny aquatic animals and plants which serve to feed young king and silver salmon, steelhead and resident trout would be increased by an increase of flow in the South Fork Eel River. These animals and plants inhabit the waters of riffle areas, where rocks provide hiding places and tumbling rapids enrich the water with oxygen.

Releases of water from the proposed Branscomb Reservoir would sweep downstream over a broader bed and increase such riffle areas. The



RUSSIAN RIVER TEMPERATURE CHANGE BELOW COYOTE DAM

young fish would benefit from these additional feeding grounds. In addition, releases of water from the proposed Branscomb Reservoir probably would improve recreation conditions along the South Fork Eel River. Campers and picnickers enjoy the sound of whispering water through riffle areas, the placid calm of deep pools and the invitation to swim which those pools present.

Appendix C and a Department of Water Resources study (Appendix A: h) detail aspects of fishery and recreation enhancement of the South Fork Eel River and relate them to water releases.

In summary, releases of stored water from the proposed Branscomb Reservoir would improve water temperature conditions, encourage early spawning, enlarge spawning areas, extend the fishing season, increase production of feed for fish and improve recreation conditions along the river. These are project benefits.

Preliminary surveys conducted by the California Department of Fish and Game and the U. S. Fish and Wildlife Service, however, show that some of the most valuable silver salmon and steelhead spawning areas exist above the proposed dam site. The inundation of these spawning areas by the proposed Branscomb Reservoir would be a detriment.

Proposed Water Releases from Branscomb Reservoir

Branscomb Reservoir would store about 30,800 acre-feet of water when filled to the level of the Branscomb Dam spillway crest. A reservoir of this capacity was selected so that water releases each year could provide the following minimum stream flow below the selected point of stream flow control: 100 second-feet of water from October 1 through April 30 (the period of fish migration), and 50 second-feet of water from May 1 through September 30.

This annual five-month reduction to 50 second-feet would improve summer recreation values at the reservoir by reducing excessive fluctuation of the reservoir water surface. A reservoir with no fluctuation of its water surface level would provide the most recreation potential for a given water surface area. However, stream flow requirements necessitate releases from storage which result in a lowering reservoir water level. Minimum fishery releases during the summer recreation season would cause the least possible lowering of the reservoir surface. The summer reduction to 50 second-feet would not harm the downstream fishery. A flow of 50 second-feet represents approximately 3,000 acre-feet a month. This controlled summer release would be about ten times greater than the average flows recorded at the Branscomb gaging station in the months of August and September for the ten-year period 1946-47 through 1956-57.

At the proposed Branscomb Dam, the mandatory minimum release throughout the year would be 25 second-feet. The released water would flow through the proposed fish ladder during the period of fish migration and would permit upstream and downstream passage of fish.

During 1923-24, runoff at the Branscomb stream gaging station measured only 22 percent of the average annual runoff for the 36-year base period (Table 5). Should runoff again drop below one quarter of its annual average, the May through September flow requirement of 50 second-feet at the point of stream flow control would be lowered. However, if the fishery is to be maintained, the flow past that point should not drop below 25 second-feet.

Before the present water release plan was adopted, a plan which would have required an annual minimum stream flow of 100 second-feet past

the point of stream flow control was proposed. However, the larger reservoir, needed to meet such a release schedule, would have undergone considerable water surface fluctuation to the detriment of recreation use of its waters. Moreover, it would have inundated a greater area of productive spawning gravels than would Branscomb Reservoir. This preliminary plan, therefore, was discarded.

Benefits from Water Releases

A monetary evaluation of benefits of the Branscomb Project to the downstream fishery and to streamside recreation was not made. Nevertheless, studies by the Department of Fish and Game indicate that downstream fishery benefits would approximate upstream fishery detriments brought about by the inundation of spawning gravels by the proposed reservoir. Streamside recreation benefits under project conditions undoubtedly would grow with the increased and more dependable river flows.

Reservoir Recreation

Visitor demand for recreation facilities will control the development of recreation areas near the proposed Branscomb Reservoir. As a result of predictions of the extent of such demand it has been proposed that reservoir recreation facilities provide for 7,400 visitors daily within ten years and 10,750 visitors daily upon completion of construction at the end of 20 years.

Recreation Facilities

Plate 5, entitled "Branscomb Reservoir Recreation Land Use Plan", shows areas proposed for recreation development. Table 7 sets forth a proposed 20-year schedule for construction and costs of recreation facilities

TABLE 7

PROPOSED SCHEDULE FOR CONSTRUCTION AND ESTIMATED COSTS OF
RECREATION FACILITIES AT BRANSCOMB RESERVOIR

Year	Area	Use	Annual visitor-day capacity		Capital expenditures	Annual operation and maintenance costs
			Subtotal	Total		
0 through 2nd	Observation Point	Day			$280,000	$ 33,600
	Administration and utility	Administrative				
	Gregg Point	100 camp units				
		50 picnic units	87,780	87,780		
3rd through 8th	Haun Creek	500 camp units	191,100	278,880	868,000	121,300
	Administration and utility	Administrative				
9th through 10th	Kato Camp	70 camp units	41,160		135,000	135,000
	Lumber Camp	1 organization camp	5,250	325,290		
11th through 20th	Kenny Creek	400 picnic units	135,800		397,000	185,000
	Boat camps:					
	Kenny Creek	14 camp units	1,570			
	Little Charlie Creek	20 camp units	2,240			
	Redwood Creek Trailer Camp (Private development)	45 trailers	13,230	478,100		

at Branscomb Reservoir, depicts the stages of this development, and shows, for each stage, the annual visitor-day capacity of the facilities.

Initial development would include an observation point near the dam construction area, administration buildings and a 100 camp and 50 picnic unit park along Rock Creek at Gregg Point. A double boat launching ramp and swimming beaches would contribute to the attractiveness of the Gregg Point Park. Plate 6, entitled "Gregg Point Recreation Development Plan, Branscomb Reservoir", shows this development. Its facilities would meet the estimated recreation demand for about two years.

Later development would include the construction of 500 camp units near Haun Creek at the southern extremity of the proposed reservoir. Facilities here would meet the estimated recreation demand for six additional years. Adjoining this area is the Division of Beaches and Parks' Admiral Standley State Park.

During the two years following the Haun Creek development, additional development would include the construction of 70 camp units at Kato Camp , midway between Branscomb and the Gregg Point development. During the same period, an area called Lumber Camp would be established adjacent to the Haun Creek units. Organizations and clubs would use Lumber Camp for group outings.

For the eleventh through the twentieth and final year of development, the construction of 400 picnic units at a reservoir site near Kenny Creek is proposed. Two boat camps accessible only by water are proposed for the western side of the reservoir. These would be the 14-unit Kenny Creek camp and the 20-unit Little Charlie Creek camp. An additional

proposal is that private interests build Redwood Creek Trailer Camp to serve 45 trailers. The site lies along the present Branscomb Road to the coast.

Excluding the nearby Admiral Standley State Park, the estimated annual visitor-day capacity of these recreation facilities upon their completion in the 20th year of development would be 478,100.

Recreation Benefits

Recreation benefits were determined as the mathematical product of the dollar value of a visitor-day times the number of visitor-days attributable to a recreation project.

Recreation benefits creditable to the Branscomb Project were projected for a period of 50 years after construction of the project. Certain assumptions preceded this projection. It was assumed that initial recreation visitor-day use of Branscomb Reservoir would approximate that of Sly Park Reservoir in the Sierra Nevada near Placerville, because Branscomb Reservoir, near Highway 101, and Sly Park Reservoir, near Highway 50, are both close to main routes of travel, and because both locations lie within attractive timbered areas. State park, national park and national forest visitation records show that in California the rate of growth in demand for outdoor recreation from 1941 through 1959 exceeded the rate of population growth during that period. It was assumed this trend would continue through the 50th year.

In projecting visitor-day use to the 50th year, consideration was given to those factors which indicate an ever-increasing demand for outdoor recreation. Such factors include:

- increased purchasing power despite inflation;
- increased leisure time resulting both from a shorter work week and from an earlier retirement age;

- improved methods of transportation;
- increased development of equipment which serves to make outdoor living more comfortable;
- increased demand for recreation facilities, resulting both from the need to counteract work day tensions and from a greater proportion of youth to age in California.

The prediction of recreation benefits of the Branscomb Project is based upon statistics obtained by a summer survey by the department of existing recreation use of the South Fork Eel River Basin. The Division of Beaches and Parks supplied visitor-day use statistics for the area. At the same time, personnel of three state parks, a resort and two motels assisted in distributing questionnaires which asked tourists to indicate, among other things, the names of their home towns, the number in their party and the number of days spent in the area. Tourists returned 2,283 completed questionnaires to the department. A report by the department (Appendix A: h) describes the survey procedures in detail.

As a result of the evaluation of the combined information from this survey, the dollar value of each visitor-day in the South Fork Eel River Basin was estimated at $2.10. This estimate required utilization of a method* which derives recreation values from consideration of visitor cost of travel to and from a recreation area. Predicitions were then made of area visitor-day use and recreation benefits with and without the project throughout the period of 50 years which, for planning purposes, has been chosen to represent project life.

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* Described in "Recreational Benefits From Upper Feather River Basin Development", Appendix A of Department of Water Resources Bulletin No. 59-2: "Investigation of Upper Feather River Basin Development", July, 1959. Pp. 135 ff.

Table 8 shows estimated annual visitor-day use of the area, both with and without the Branscomb Project, during the various stages of project development. It also shows estimated annual recreation benefits attributable to the project.

TABLE 8

ESTIMATED VISITOR-DAY USE AND BENEFITS OF
RECREATION FACILITIES AT BRANSCOMB RESERVOIR

Year	Annual visitor-days with project	Annual visitor-days without project	Annual visitor-days creditable to project	Annual recreation benefits creditable to project
0 through 2nd*	70,500	4,300	66,200	$139,000
3rd through 8th*	221,300	5,000	216,300	454,200
9th through 10th*	319,000	6,200	312,800	656,900
11th through 20th*	412,000	9,700	402,300	844,800
20th	478,100	12,500	465,600	977,800
30th	478,100	21,500	456,600	958,900
40th	478,100	32,000	446,100	936,800
50th	478,100	48,000	430,100	903,200

* Average.

Water Quality as Related to Recreation Use

No generally accepted water quality standards exist for the recreation use of water by swimmers, boaters and water skiers. Enthusiasts of such sports apparently consider esthetic rather than sanitary factors.

Increased body contact, however, tends to increase the possibility of disease-causing bacteria in the water. Intense recreation use thus necessitates greater consideration of sanitary factors. U. S. Public Health Service standards for drinking water will serve to evaluate such factors. Disease-causing bacteria may exist in apparently pure water, while turbid waters, apparently contaminated, may be pure.

Plankton colonies and moss covered rocks generally discourage recreation use. Plankton would develop in the proposed Branscomb Reservoir under the proper conditions of sunlight, water temperature and organic and inorganic nutriments. However, it is believed that such growth will not be sufficient to detract from the use of the reservoir for water contact sports.

CHAPTER IV. MAJOR STRUCTURES AND PROJECT COSTS

Chapter III discussed the use to which the Branscomb Project would be put. This chapter describes the structures which would make that use possible (the proposed Branscomb Dam and Reservoir), outlines the geology of the suggested dam site, and shows that the site will support the dam and that the area will provide sufficient materials for construction. In addition, this chapter outlines the economic aspects of the Branscomb Project, with particular attention to the evaluation of benefits and costs, and their relationship.

Geology

Rocks of the Franciscan group of the Jura-Cretaceous period, which underlie most of the South Fork Eel River Basin, are estimated to be about 100,000,000 years old. The Franciscan group consists of sedimentary and volcanic rocks with some serpentine intrusions. Intense pressures have folded, faulted and sheared these rocks. Heavy rainfall has helped to form deep soil and dense vegetation. Landslides, soil creep and rock slump are common along the South Fork Eel River.

Franciscan shales and sandstones of marine sedimentary origin underlie the Branscomb dam site. Geologic exploration has shown foundation characteristics of the site to be satisfactory for an earthfill dam to a height of 200 feet. Plate 7, entitled "Geology of Branscomb Dam Site", depicts the results of this exploration. As shown on Plate 7, the rock units dip to the east and strike toward the northwest. Dip is the angle which a rock stratum makes with a horizontal plane. Strike is the direction of the line formed by the intersection of a rock stratum with a horizontal plane.

The formation strike lies oblique to the stream course and nearly perpendicular to the axis of the proposed Branscomb Dam.

The underlying rock at the dam site was drilled to determine bedrock characteristics. The drill cores indicated the existence of intensely weathered, slumped shale with occasional lenses of resistant sandstone. Permeability was measured by determination of the amount of water, under pressure, pumped into the drill holes which was lost into the bedrock. Water losses during the pressure testing proved to be slight, an indication that foundation leakage should not be excessive.

Subsurface materials were exposed at six sites by trenching with a bulldozer to enable determination of the character of the soil. The trenches showed that preparation of the foundation for both abutments of the impervious section of the dam would necessitate stripping of soil and slumped shale to a depth of from five to eight feet.

Adequate construction materials for both the impervious and semi-pervious sections of the dam are available at the dam site and within two and one-half miles upstream from the site. Sandstone suitable for riprap to cover the upstream face of the dam lies near the right abutment and also at the Rock Creek Quarry site about 1.5 air miles distant. A Department of Water Resources report (Appendix A: g) details geology of the Branscomb dam site.

Branscomb Project

The major components of the Branscomb Project are the dam, its outlets (spillway, fish ladder and outlet pipe) and the reservoir.

Branscomb Dam

The proposed Branscomb Dam would be an earthfill structure with a concrete-lined spillway and fish ladder. The dam site lies on the South Fork Eel River about four miles downstream from Branscomb and one mile upstream from Jack of Hearts Creek. Stream bed elevation at this point is 1,405 feet above mean sea level.

Branscomb Dam would rise 126 feet from stream bed to the spillway crest and another 19 feet to the crest of the dam. The dam would be 750 feet long and 30 feet wide at the crest. The structure would contain an estimated 1,443,000 cubic yards of fill material. A roadway located about a quarter of the way down the downstream face of the dam would permit passage of vehicles from one side of the river to the other. Releases of water from the reservoir would pass over either the spillway, down the fish ladder into a fish collection pool, or through an outlet pipe beneath the dam and into the same pool.

Plate 8, entitled "Branscomb Dam, South Fork Eel River", shows general features of the proposed dam.

Spillway. The spillway would be of the ogee (s-shaped profile) type. Located on the right (east) abutment of the dam, it would contain no gates and would discharge through a converging concrete-lined chute into a fish collection pool immediately below the dam. At the height of the project design flood--an estimated once-in-a-thousand year flood with a peak inflow into the reservoir of 29,700 second-feet and a peak outflow of 24,500 second-feet--reservoir waters would rise about 13 feet above the spillway crest or to within six feet of the dam crest.

Fish Ladder. The fish ladder adjacent to the spillway would provide for passage of fish at varying reservoir stages. As the reservoir

level is drawn down, operators would lower sliding gates on the first twelve fish ladder pools to provide controlled flow through the pools. These pools would be eight feet long, six feet wide and six feet deep, and would step at one-foot intervals from the river level up to the reservoir level. In most years, flow through the fish ladder could be controlled from the time winter rains fill the reservoir until the following August.

Should low reservoir water storage exist in the early days of the fish migration period (October 1 through April 30), pumps would pour water into the fish ladder to allow fish to pass over the dam. Under these conditions, fish reaching the top of the ladder would leap at a false falls, pass through the falls and slide down a chute into the reservoir. The proposed fish ladder would permit the upstream passage of about 12,000 adult fish a day. Fish could pass down the ladder when the reservoir is full to the spillway crest.

Outlet Works. The intake tower of the reservoir outlet works would permit the release of water from varied reservoir elevations so that warm water from near the surface could mix with cold water from greater depths. A choice of mixtures would permit control of the temperature of the released water. The outlet works could release 275 second-feet of water with a filled reservoir and 160 second-feet of water at minimum pool. This discharge capacity would permit drainage of the reservoir to facilitate repair of the dam.

Branscomb Reservoir

An operation study based on precipitation and runoff records of past years shows that, with only a few exceptions, fluctuation of the water surface of Branscomb Reservoir during the summer recreation season would be

minor. Plate 9, entitled "Branscomb Reservoir Operation: Fluctuation of Water Surface Elevation", presents the results of this study.

High recreation use of the reservoir is anticipated under the proposed schedule of water releases. On June 1 of most summers, the reservoir would stand at normal pool (spillway crest level) and offer an estimated 775 acres of water surface area to swimmers, boaters and water skiers. By Labor Day, the reservoir water surface area would have diminished only slightly--to an estimated 710 acres.

Table 9 summarizes estimates of inflow and outflow at the site of Branscomb Reservoir for the period extending from runoff year 1935-36 to runoff year 1954-55. Proposed water releases from Branscomb Reservoir are described in detail in Chapter III (pages 27-28).

Water flowing into the proposed Branscomb Reservoir would deposit sediments along the bottom of the reservoir. Estimates of the amount of sedimentation that would occur in Branscomb Reservoir were based on sedimentation records of three reservoirs less than 40 miles from the Branscomb site. These are Ridgewood Reservoir, which lies along a tributary to the Russian River, and Morris Reservoir and Lake Pillsbury, both of which lie along tributaries of the Eel River. At these reservoirs, the respective average annual rates of sedimentation in acre-feet of sediment per square mile of drainage area were 0.22, 0.28 and 0.71.

The highest of these observed rates of sedimentation was selected to estimate the total volume of sedimentation at Branscomb Reservoir through the 50-year period of operation. The sediment volume over this period, amounting to an estimated 1,500 acre-feet, would be about five percent of the total storage capacity of the reservoir. Such an accumulation over 50 years would not affect appreciably the operation of Branscomb Reservoir for recreation use and fishery improvement.

TABLE 9

BRANSCOMB RESERVOIR OPERATION STUDY
(In acre-feet)

Year	Storage on October 1	Inflow	Water loss: Fish release	Water loss: Evaporation	Water loss: Spill
1935-36	23,200	118,300	19,400	1,200	96,200
37	24,700	72,100	23,400	1,200	47,400
38	24,800	217,800	11,900	1,200	204,800
39	24,700	60,700	15,000	1,200	46,100
40	23,100	142,800	18,500	1,200	121,900
1940-41	24,300	161,400	11,900	1,200	146,400
42	26,200	147,200	12,100	1,200	133,400
43	26,700	120,400	12,600	1,200	108,000
44	25,300	50,100	16,000	1,200	33,900
45	24,300	102,500	12,100	1,200	88,400
1945-46	25,100	133,500	11,900	1,200	122,400
47	23,100	51,600	19,600	1,200	29,800
48	24,100	102,200	9,400	1,200	88,200
49	27,500	97,200	15,600	1,200	84,900
50	23,000	92,100	19,800	1,200	70,600
1950-51	23,500	152,600	8,000	1,200	143,500
52	23,400	158,700	11,400	1,300	144,700
53	24,700	151,800	13,500	1,200	134,000
54	27,800	143,400	10,700	1,200	133,800
1954-55	25,600	62,600	12,100	1,200	50,500

NOTE:

Storage on October 1 plus inflow less water loss equals storage on following October 1.

Normal pool is 30,800 acre-feet; minimum pool is 10,500 acre-feet.

By June 1, many vacationists would be using the reservoir recreation facilities. During the years covered by this table, the reservoir on this date generally would be filled to its normal pool storage capacity of 30,800 acre-feet. Exceptions are runoff years 1935-36, when storage would have been 30,700 acre-feet, and 1938-39, when storage would have been 30,200 acre-feet.

Table 10 shows the general features of the proposed Branscomb Dam and Reservoir.

Project Costs

The costs of the Branscomb Project include construction of the dam, purchase of property, relocation of a sawmill and two roads, and construction of recreation facilities. Table 11 summarizes the estimated capital expenditures of the proposed Branscomb Dam and Reservoir.

Project cost estimates were based on the initial purchase of all lands classified as having recreation use (Plate 5), regardless of the proposed stages in the development of that use. Initial purchase of those lands would assure availability of reservoir recreation facilities to all the people of the State. The proposed development of recreational lands was discussed in Chapter III. To ensure access to the proposed reservoir, it is considered desirable to purchase all land surrounding the reservoir to a horizontal distance of 300 feet, measured from the water line of the reservoir at dam crest level. This line would border the reservoir at an elevation of 1,550 feet above mean sea level.

The cost of relocating a sawmill which operates throughout the year in the proposed reservoir area would be considerably less than the 1960 replacement value of the sawmill. This report assumes relocation of the mill rather than its purchase.

Reservoir waters would inundate sections of the Branscomb Road and a branch road leading downstream past the dam site. To provide access to all areas presently accessible, these road sections would be relocated above the maximum high water line of the reservoir. The 13 miles of relocated road would provide excellent access to recreation facilities proposed for the

TABLE 10

GENERAL FEATURES OF BRANSCOMB DAM AND RESERVOIR

Dam	
Location	N ½, Section 4, T21N, R16W, MDB&M
Drainage area in square miles	41.5
Type	earthfill
Crest elevation above mean sea level in feet	1,550
Crest height above stream bed in feet	145
Crest length in feet	750
Crest width in feet	30
Impervious core crest width in feet	20
Slopes	
Upstream face	4.5:1
Downstream face above roadway berm	3.0:1
Downstream face below roadway berm	2.0:1
Impervious section: upstream face	0.5:1
Impervious section: downstream face	0.5:1
Riprap thickness on upstream face in feet	3
Quantity of materials in cubic yards	
Semipervious	1,109,000
Impervious	194,000
Filter and drains	100,000
Riprap	40,000
TOTAL	1,443,000
Spillway	
Crest elevation above mean sea level in feet	1,531
Crest height above stream bed in feet	126
Crest length in feet	140
Design flood surcharge head in feet	13.3
Design flood residual freeboard in feet	5.7
Design flood peak inflow in second-feet	29,000
Design flood peak outflow in second-feet	24,500
Outlet Works	
Maximum possible release at normal pool in second-feet	275
Maximum possible release at minimum pool in second-feet	160
Fish Ladder	
Maximum design release in second-feet	100
Design release in second-feet	25
Pumped release in fish ladder at reservoir minimum pool in second-feet	25
Ladder pool size: minimum inside measurements in feet :	
Length	8
Width	6
Depth	6
Maximum elevation difference between pools in feet	1

TABLE 10 (continued)

GENERAL FEATURES OF RAMSCOMB DAM AND RESERVOIR

Reservoir

Minimum pool storage capacity in acre-feet	10,500
Normal pool storage capacity in acre-feet	30,300
Maximum pool storage capacity in acre-feet	47,600
Surcharge storage capacity in acre-feet*	16,800
Minimum pool surface area in acres	330
Normal pool surface area in acres	775
Estimated pool surface area on Labor Day in acres	710

* Difference between storage capacity at normal and maximum pools.

TABLE 11

ESTIMATED COST OF BRANSCOMB DAM AND RESERVOIR

(Based on prices prevailing in January, 1960)

Item	Quantity	Capital expenditure
Dam		
Stream diversion		$ 100,000
Foundation excavation	220,000 cubic yards	207,000
Embankment		
Semipervious	1,109,000 cubic yards	
Impervious	194,000 cubic yards	
Filters, drains and riprap	140,000 cubic yards	
Grouting	5,000 lineal feet	
Embankment subtotal		1,311,000
Spillway excavation	670,000 cubic yards	1,270,000
Outlet works		275,000
Subtotal		$3,163,000
Contingencies: 15%		474,000
Subtotal		$3,637,000
Engineering and Administration: 15%		545,000
Subtotal		$4,182,000
Interest during construction period @ 4%		167,000
Total		$4,349,000
Reservoir		
Road relocation	12.8 miles	$1,620,000
Land and improvements		450,000
Clearing		250,000
Subtotal		$2,320,000
Contingencies: 15%		348,000
Subtotal		$2,668,000
Engineering and Administration: 15%		400,000
Subtotal		$3,068,000
Interest during construction period @ 4%		123,000
Total		$3,191,000
Total: Dam and Reservoir		$7,540,000
Fish Ladder		$ 305,000
Contingencies: 15%		$ 46,000
Subtotal		$ 351,000
Engineering and Administration: 15%		53,000
Subtotal		$ 404,000
Interest during construction period @ 4%		16,000
Total		$ 420,000

reservoir area. The new road would be constructed to Federal Aid Secondary road standards and would provide access comparable to the existing road system.

To facilitate the evaluation of the cost of Branscomb Reservoir recreation facilities, the Division of Beaches and Parks supplied estimates of camp, picnic and sanitary unit construction costs as well as operation and maintenance costs for all recreation facilities. The Wildlife Conservation Board supplied estimates of construction costs for the double boat launching ramp.

Table 12 summarizes and supplements material contained in Tables 7, 8, and 11, and shows estimates of Branscomb Project benefits, revenues and costs. The table shows that the initial capital expenditure for the Branscomb Project would be $8,240,000. Of this figure, $7,540,000 is for the dam and reservoir, $420,000 is for the fish ladder and $280,000 is for reservoir recreation facilities. Over the 20-year period of development, the total capital cost of the project would be an estimated $9,640,000. This figure represents additional capital expenditures of $1,400,000 for the reservoir recreation facilities constructed during the first twenty years of project life.

After 50 years, the total operation and maintenance costs of the Branscomb Project (including costs of replacement, general expense and insurance) would be $10,760,000, distributed as follows: operation and maintenance of reservoir recreation facilities, $8,470,000; dam and reservoir, $1,750,000; fish ladder, $540,000.

The sum of all capital expenditures ($9,640,000) and operation and maintenance costs ($10,760,000) over the 50-year period would be $20,400,000. The present worth of this sum is $13,854,000. From the viewpoint of the

TABLE 12

ESTIMATED BENEFITS, REVENUE AND COSTS FOR BRANSCOMB PROJECT

(in dollars)

Year	Annual recreation benefits attributable to project	Annual recreation revenue	Recreation facilities: Capital expenditures	Recreation facilities: Annual operation and maintenance costs [a]	Dam and reservoir: Capital expenditure	Dam and reservoir: Annual operation and maintenance costs [a]	Fish ladder: Capital expenditure	Fish ladder: Annual operation and maintenance costs [a]
Project inception			280,000		7,540,000		420,000	
0 thru 2	139,000 [b]	14,800 [b]		33,000		35,000		10,800
3 thru 8	454,200 [b]	46,500 [b]	868,000	122,000		35,000		10,800
9 thru 10	656,900 [b]	67,200 [b]	135,000			35,000		10,800
11 thru 20	844,800 [b]	79,600 [b]	397,000	185,000		35,000		10,800
21 thru 50	974,500 [b]	100,700 [b]		185,000		35,000		10,800
50-year totals	42,000,000	4,260,000	1,680,000	8,470,000	7,540,000	1,750,000	420,000	540,000
Present Worth [c]	15,900,000		1,450,000	3,460,000	7,540,000	752,000	420,000	232,000

[a] Operation and maintenance costs include replacement, general expense and insurance.
[b] Average.
[c] From the viewpoint of the investor, the present worth of a future expenditure or series of expenditures is the present money value necessary to secure the return of that future expenditure with interest at a given rate, in this case: 4%.

investor, the present worth of a future expenditure or series of expenditures is the present money value necessary to secure the return of that future expenditure with interest at a given rate, in this case, four percent.

Table 12 also shows that in the same 50-year period, the sum of total recreation benefits attributable to the Branscomb Project would be $42,000,000. The present worth of this sum is $15,900,000.

Benefit-Cost Ratio

The development of water resources creates intangible as well as primary benefits. Intangible benefits, however, cannot be measured in monetary terms. Therefore, only primary benefits are used to evaluate project accomplishments.

The comparison of the present worth of project benefits and the present worth of project costs is expressed in the form of a ratio, called the benefit-cost ratio. Studies of reservoir capacities ranging from 22,000 to 100,000 acre-feet show that the maximum benefits occur at a reservoir capacity of 30,800 acre-feet, on the basis of evaluation of a single purpose recreation reservoir. At this capacity, the benefit-cost ratio of the Branscomb Project is 1.15 to 1.0.

Since the foregoing derivation of the benefit-cost ratio of the Branscomb Project includes benefits creditable to reservoir recreation only, and therefore is only a partial measure of the economic justification of the project, further investigation by the Department's of Fish and Game and Parks and Recreation of recreation and fisheries benefits and detriments would be required before a conclusive evaluation of the project could be made.

Financial Feasibility

Assembly House Resolution No. 296, June 1957, under which this investigation was authorized, called for preparation of a report on plans, costs, benefits, "... and such other information as is necessary to determine the economic and financial feasibility to assist the Legislature in considering authorization of the project ...." This report complies with the authorization to the extent that engineering plans were established for the Branscomb Project, and the costs and benefits were estimated with the finding of a favorable benefit-cost ratio based entirely on recreation benefits. Because no purposes other than recreation could justifiably be included in the project, no cost allocations or repayment plans are included.

During the course of the investigation, no local agency indicated a willingness or capability to construct the project and repay its costs. The recreational benefits computed herein would accrue to the people of the State of California rather than to a limited zone of benefit in the vicinity of the project. It is suggested that financial feasibility of the Branscomb Project would be contingent upon authorization by the Legislature for construction with state funds on a non-reimbursable basis, and operation of the completed project by the Department of Parks and Recreation.

The Division of Beaches and Parks of the Department of Parks and Recreation was directed by House Resolution No. 80, 1962, to study the feasibility of the project and its financing as a portion of the State Park System. The results of their study, due in January 1963, will be a valuable contribution to the overall determination of the feasibility of the Branscomb Project.

CHAPTER V. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents conclusions and recommendations resulting from detailed studies of the reservoir recreation potential of the proposed Branscomb Project, and limited studies of the effects the project would have on the fisheries of the South Fork Eel River Basin. In preparing the conclusions and recommendations, consideration also was given to Assembly Concurrent Resolution No. 56 and to comments received at the public hearing on the preliminary edition of this bulletin.

Conclusions

It is concluded that:

1. The redwood region of Humboldt and Mendocino Counties provides a great attraction for tourists from the State and Nation. Although the number of fish in the South Fork Eel River has declined, use of the river for salmon and steelhead fishing is substantial. Recreation is an industry of major importance to the economy of the basin.

2. Mean annual precipitation in the South Fork Eel River Basin ranges from 60 to 115 inches with about 75 percent of this precipitation occurring during the months from December through April and about 85 percent of the total annual stream runoff occurring during the same period.

3. The drainage area above the proposed Branscomb damsite occupies 42 square miles, or about six percent of the total area of the South Fork Eel River Basin. During the 36-year base period (1920-21 through 1955-56) the average annual discharge

of this drainage area was 105,800 acre-feet, or about seven percent of the total runoff of the South Fork Eel River Basin.

4. Streamflow at the Branscomb stream gaging station from May through November is frequently less than five second-feet and has reached a minimum of 1.4 second-feet. Streamflow is lowest during the summer and fall months when recreation use of the area is highest. Such low streamflow, combined with summer stream temperatures sometimes fatal to salmon adversely affects the fishery and detracts from the recreational attractiveness of the area.

5. The quality of water in the South Fork Eel River presently is suitable both for the fishery and for recreation use with the exception of high temperature conditions that occur during periods of low flow that are detrimental to both.

6. The main stream channel and tributaries of the South Fork Eel River above the proposed Branscomb damsite appear to contain some of the best spawning gravels available in that basin for silver salmon and steelhead trout.

7. To provide downstream fishery benefits that would approximately offset upstream detriments due to inundation of spawning gravels, a reservoir at the Branscomb site should be operated to provide a minimum streamflow of 50 second-feet from May 1 through September 30 and a minimum streamflow of 100 second-feet during the remainder of the year, measured at Rattlesnake Creek, some 14 miles downstream from the dam, and to provide a minimum release of 25 second-feet at the dam, based on preliminary studies by the Department of fish and Game. Additionally, a fish ladder would be required to permit passage of fish past the dam.

8. Summer flows larger than those considered necessary to meet minimum fishery requirements downstream from the proposed Branscomb Dam could greatly increase streamside recreation opportunities along the many miles of the South Fork of the Eel River readily accessible from U. S. Highway 101. Detailed studies of this recreation potential would be required to establish the size and operation criteria for the proposed Branscomb Project that would maximize the net total recreation and fishery enhancement benefits throughout the basin.

9. Of the five damsites considered for Branscomb Project, the selected one, located about one mile upstream from Jack of Hearts Creek, would provide sufficient storage to meet downstream minimum fishery flow requirements for the least capital expenditure.

10. Maximum benefits would occur with a reservoir capacity of 30,800 acre-feet. On the basis of evaluation of a single purpose recreation reservoir meeting the suggested minimum fishery release.

11. The proposed reservoir would provide more than 700 acres of water surface for summer boating, fishing, water skiing, skin diving and swimming from picnic and campgrounds located in a redwood forest area.

12. It is estimated that the initial capital expenditure would be $8,240,000, including reservoir recreation facilities. The sum of the present worth of all capital expenditures and operation and maintenance costs during the 50-year repayment period for the Branscomb Project would be $13,850,000.

13. Primary benefits of the Branscomb Project would result from use of reservoir recreation facilities. Such use is considered

to be a statewide benefit. During the twentieth year of project life and thereafter, recreation facilities at the proposed Branscomb Reservoir would receive an estimated annual 478,000 visitor-days of use.

14. The total present worth of the primary recreation benefits attributable to the Branscomb Project, based on $2.10 per visitor-day, during its 50-year repayment period is estimated to be $15,900,000.

15. Considering only reservoir site recreation benefits the benefit-cost ratio of the Branscomb Project would be about 1.15 to 1.0, which indicates that the project is economically justified.

16. A conclusive evaluation of the project would require a detailed determination of recreational and fisheries benefits and detriments throughout the basin.

17. Based on comments received on the preliminary edition of Bulletin No. 92 from the Departments of Fish and Game and Parks and Recreation, and other interested parties, and in consideration of the relatively small excess of benefits over costs found for the Branscomb Project, the project should not be considered for authorization at this time. Detailed studies should be made of alternative projects in the South Fork Eel River Basin as to their potential for fisheries enhancement, recreation, and other uses, from a basin-wide standpoint.

Recommendations

In order to ensure the selection of the optimum plan of development for the South Fork Eel River Basin it is recommended that:

1. The Departments of Fish and Game and Parks and Recreation make further studies of the fisheries and recreation benefits and detriments attributable to the Branscomb Project. This is in accordance with Assembly Concurrent Resolution No. 56, Chapter 128, 1963.

2. Studies be made by the Departments of Fish and Game, Parks and Recreation, and Water Resources to fully evaluate alternative projects on a basin-wide development concept for the South Fork Eel River Basin as to their potential for fisheries enhancement, recreation, and other uses.

3. The Branscomb Project as described herein, not be considered for authorization at this time pending completion of the foregoing studies.

4. Funds be included in the 1966-67 budget for the initiation of a three-year program to accomplish the studies recommended under items 1 and 2 above, to be conducted jointly and concurrently by the Departments of Fish and Game, Parks and Recreation, and Water Resources.

APPENDIX A

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APPENDIX B

COMMENTS OF THE DEPARTMENT
OF PARKS AND RECREATION,
DIVISION OF BEACHES AND PARKS,
ON THE
BRANSCOMB PROJECT

JUNE 1962

STATE OF CALIFORNIA

SACRAMENTO 14

Interdepartmental Communication

To: Mr. John M. Haley
Northern Branch
Department of Water Resources
1108 - 14th Street
Sacramento 14, California

Date: June 18, 1962

File No.

From: The Resources Agency of California
Department of Parks and Recreation
Division of Beaches and Parks

Subject: Project Investigation Bulletin No. 92

We have reviewed the above-mentioned bulletin and, in general, believe it to be thorough and adequate in the treatment of the subject covered.

With the knowledge of the area which we presently possess, we cannot agree that this project is desirable for inclusion in the State recreation plan at present, as many other projects and areas afford better and more practical expenditure of available recreation dollars. We feel that Branscomb Reservoir cannot measure up to many other projects throughout the State. As time passes, and other projects are accomplished, the need for and desirability of the Branscomb project may rise in priority.

Another aspect of this project has not, in our opinion, received sufficient study. This is the value to be derived from larger, more uniform flows on the Eel below Branscomb. We have noticed a deterioration of the stream in the past decade. As early as June, streamflows are meager. This results in loss of good swimming areas fishing areas, scenic values and a consequent loss of economic values to locally-situated enterprises. Continued low flows may possibly adversely affect the entire ecology of the Redwood forest in the parks along the Eel River, and have an adverse effect because of poor channel conditions during periodic runoffs.

We believe that these values should receive more study and be related against the value of "on-site" recreation, as releases sufficient to enhance the river would surely increase drawdown and detract from the value and practicability of "on-site" activities at the reservoir itself.

We now have before us House Resolution No. 80, 1962, directing this Division to study the feasibility of the project and its financing as a portion of the State Park System. This we will do, to the limits of available staff, during the summer and fall. We will look forward to conferring with your staff in the course of this investigation.

Edward F. Dolder

EDWARD F. DOLDER, Chief

EFD:RBH:bc
cc: Mr. Warren

BULLETIN NO. 92

BRANSCOMB PROJECT INVESTIGATION

APPENDIX C

AN AMENDED REPORT ON THE EFFECT OF THE BRANSCOMB PROJECT ON THE FISHERY OF THE SOUTH FORK EEL RIVER

by

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under the supervision of

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STATE OF CALIFORNIA

DEPARTMENT OF FISH AND GAME

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AN AMENDED REPORT ON THE EFFECT OF THE BRANSCOMB PROJECT ON THE FISHERY OF THE SOUTH FORK EEL RIVER

INTRODUCTION

An evaluation of the Branscomb Project was first submitted in August of 1960 while engineering plans had not yet crystallized. Since then the engineering features of the project have been decided upon. Therefore, the original report has been amended to reflect these changes.

The California Water Plan, as described in Bulletin No. 3 of the Department of Water Resources, proposed the construction of stream flow maintenance dams in north coastal drainages which would not be affected by ultimate water project developments. It was envisioned that these drainages "would be developed either solely or primarily in the interests of enhancement of the fishery and of wildlife and recreational opportunities".

The concept of coastal stream flow maintenance dams is believed to be sound. These dams, if constructed in the headwater areas of certain north coastal drainages, would be beneficial to fish life. However, it does not necessarily follow that the same degree of benefits would be achieved in all instances. There are many factors peculiar to each drainage which require that a critical, thorough study be made before as well as after project development, before the full effect of this type of project can be determined.

The Department of Water Resources has been investigating the possibilities of this type of development on the South Fork Eel River near the community of Branscomb. A dam at this location would be constructed primarily for the improvement of the fishery and recreational conditions. Included in the late stages of the investigation, was a study by the Contract Service Section of the Department of Fish and Game to evaluate the effects of the

Branscomb Project upon the fishery of the South Fork Eel River. This study was conducted in accordance with Inter-Agency Agreement Number 150345 with the Department of Water Resources.

Purpose of Report

The purpose of this report is to present the results of the evaluation study and to recommend objectives that should be considered in future studies. This evaluation is based upon field investigations by Contract Service Section biologists; review of available literature; records of the Department of Fish and Game; reports and records furnished by the U. S. Fish and Wildlife Service; and discussions with personnel of the agencies concerned.

Scope and Limitations of Report

The field investigation consisted of 10 days of observations during the periods of June 8, August 15 - 17, 25 - 26, September 2 - 3, and October 21, 1959. These surveys were made of sections of the South Fork Eel River between the mouth of headwaters area, as well as sections of certain tributaries. The primary purposes of these surveys were to delineate spawning and nursery areas, particularly in the areas to be affected by the proposed project, and to determine through visual observations the distribution and general magnitude of fish populations in the main river. Lack of personnel and higher priority of other projects were responsible for the limited scope of the investigation.

PROJECT DESCRIPTION

Engineering Features

Present planning by the Department of Water Resources envisions the construction of a dam on the South Fork Eel River in Mendocino County, approximately 5 miles below the community of Branscomb. The dam site is located in Section 4, T. 21 N., R. 16 W., M.D.B.&M.

The dam would be an earthfill structure approximately 145 feet high with a crest elevation of 1,550 feet. An outlet would be provided low on the dam for stream bed releases. Suitable fish passage facilities would be provided.

The reservoir would store approximately 30,800 acre-feet of water and would have a surface area of 775 acres at normal pool elevation of 1,531 feet. The minimum pool, at an elevation of 1,495 feet, would have a capacity of 10,500 acre-feet and a surface area of 380 acres.

At maximum storage, the reservoir would inundate approximately 5.75 miles of the South Fork Eel River, 0.8 mile of the 2-mile long Redwood Creek Canyon, extend approximately the same distance up the 4-mile length of Dutch Charlie Creek, and 0.5 mile up Rock Creek (3 miles in length), forming a Y-shaped pool some 5.75 miles in length and varying in width from 1/2 to 3/4 mile. In all about 9.3 miles of the 46 miles of stream bed above the dam site would be inundated.

Proposed Operation

The operational study is based on storage of water in the reservoir for the 35-year period 1920 to 1955, with a release of water directly to stream

bed sufficient to provide minimum flows from May 1 through September of 50 cfs at the mouth of Rattlesnake Creek some 14 miles downstream from Branscomb Dam. Flows of 100 cfs would be maintained the remainder of the year.

Under the operating schedules presently being considered, the average annual fluctuation of the reservoir surface elevation would be approximately 18 feet. The average depth of the reservoir during the critical summer-fall high temperature period of July through October would be about 30 feet. The reservoir would be expected to fill each year with heavy spill during January, February, and March of most years.

Project Costs

Planning engineers estimate present (1959) construction costs of the Branscomb project to be approximately $10,000,000 for the dam and appurtenances. The incorporation of any required fish-maintenance facilities would increase the cost.

GENERAL DESCRIPTION OF PROJECT AREA

Rising at an elevation of 2,400 feet about 7 airline miles east of Branscomb, the South Fork Eel River drains an area of 649 square miles as it flows northwesterly some 100 miles through Mendocino and Humboldt Counties to its confluence with the main Eel River near Dyerville.

The watershed is located entirely within the Redwood Transition Life Zone. A comparatively deep, narrow canyon, with slopes timbered with Douglas fir and madrona rising steeply from it, characterizes the upper section of the drainage below Branscomb. In the reservoir area itself, excepting for small cleared areas around Branscomb, the land generally either is logged-off or timbered with second growth and brushy woodland. The mid and lower reaches of the drainage are more wide and open, the stream in the lower section being bordered with extensive flats on each side covered with redwoods. Stream gradients range from moderately steep in the headwaters section of the drainage to relatively slight in the lower reaches. Benbow Dam, a 44-foot high concrete structure located 35 miles above the mouth of the South Fork Eel River, is the only known artificial obstruction to fish life in the main channel. A fishway permits the passage of migrant fish past this point.

The climate of the project area is considered to be generally mild although annually subject to extremes of heat and cold. Minimum and maximum air temperatures of 16° and 104° F. have been recorded at Branscomb during a 21-year period of record. Temperatures have exceeded 100° for every year of record (1955-59) at the Cedar Creek Fish Hatchery. Temperatures as high as 112° have been recorded at Garberville and over 100° at Richardson Grove State Park during the months of July and August. Temperatures are greatly reduced during the winter months when the bulk of precipitation occurs. Precipitation

and runoff are highest during the winter and spring months as in other north coastal drainages. The period of lowest stream flows occurs in the late summer and fall.

The U. S. Geological Survey has maintained a gaging station on the South Fork Eel River a few miles below Branscomb since 1946 and one at Garberville during the periods 1911-13 and 1939-40. Another gaging station has been maintained near Miranda since 1940. The flow at the Branscomb gaging station averaged 173 second-feet over the 10 water years of record. The maximum instantaneous discharge was 20,100 cfs (December 22, 1955) and the minimum, 1.4 second-feet (September 24, 1949) over the same period. The lowest flows usually occur during the months of July, August, September, and October. The average discharge for these four months during the 10-year period was 4 second-feet. Peak flows at this station generally occurred in January and less often in December and February.

The same discharge pattern of peak and low flows is evidenced at the Miranda gaging station. The average discharge over the 16 years of record was 1,809 second-feet. The maximum instantaneous discharge was 173,000 second-feet (December 22, 1955) and the minimum, 9 second-feet (October 17, 1944).

EXISTING FISHERIES

General

The South Fork Eel River supports sizable runs of king salmon, silver salmon, and steelhead trout. These three species of anadromous fish support the major fishery of the river, the first two species contributing to both the sport and commercial fishery, while the latter is of significant importance to the large river sport fishery.

Many details of the life history of salmon and steelhead trout in the South Fork Eel River remain unknown. It is known, however, that the eggs of these three species are deposited in the gravel of freshwater streams from which the young emerge after hatching. The young fish then remain in the streams for varying lengths of time, steelhead trout and silver salmon remaining for a year or more. They then migrate downstream to the sea. Most of their growth is accomplished in the salt water and when sexually mature, usually after 1 to 4 years in the ocean, the adult fish ascend the main river and tributaries for the purpose of spawning. They spend from 2 weeks to several months in the streams until they are completely ripe, after which they deposit and fertilize their eggs in the gravel, thus completing the life cycle of the species.

King Salmon

Only a fall run of king salmon occurs in the South Fork Eel River. The first spawning run of king salmon generally enters the main Eel River from the ocean in August. The fish enter the lower river in increasing numbers between August and October, remaining in the lower pools and estuary until fall rains enable them to move farther upstream. The occurrence of these rains appears to be one of the factors determining the time and extent of spawning

migrations. As a rule, however, the first kings appear in the fishway at Benbow Dam during the latter part of October or the first part of November, the run peaking during the middle and latter part of December, with the last salmon passing as late as the middle of February.

According to observations made by Department of Fish and Game personnel and data obtained from the U. S. Fish and Wildlife Service, spawning usually begins in late October, peaks in November, and in some years continues through January. Most of the fish spawn in the sections of the drainage above the mouth of Salmon Creek although scattered spawning, particularly by late arrivals, occurs below this point. In years of ample stream flows, tributaries in the upper reaches of the drainage reportedly are utilized heavily. Late spawners are confined to the lower main stem of the drainage, usually below Benbow Dam.

Although king salmon are taken in the lower river sport fishery when they first enter the river in August, comparatively few fish are taken by anglers until later in September or October. With the beginning of rains, the angling becomes more intense. Whenever water conditions permit, the anglers follow the runs as the fish make their way up the streams to the spawning grounds.

Downstream migration studies conducted by the Department of Fish and Game in 1939 revealed a sizable migration of young king salmon downstream past Benbow Dam from April to July, with the bulk of migrants passing the dam during June.

Silver Salmon

Although the first sea-run silver salmon are sometimes taken by anglers in the lower rain river as early as September, they usually are not

present in substantial numbers until November. Again depending upon rains, the migration usually begins in mid-October, peaking during December or early January, and continues sometimes until March. Since these runs coincide with the periods of greatest rainfall when the waters are high and turbid, very few of these fish are taken by anglers.

During the 1939 studies, young silver salmon were observed migrating downstream past Benbow Dam from April through June, with the peak of the migration occurring during May.

Steelhead Trout

Fresh-run adult steelhead usually enter the lower main river as early as April or May. These are early-run fish that migrate upstream to sections of the Middle Fork Eel and Van Duzen Rivers where they rest in deep holes until the following fall or winter when they spawn.

The spawning migrations in the South Fork Eel River ordinarily begin during mid-October, peak in December or January, and have been observed at Benbow as late as May. As with silver salmon, the heaviest migration of these fish usually coincides with the period of greatest rainfall. The subsequent high, roily waters in the river system generally results in few fishable days for these two species.

Young steelhead were observed migrating downstream past Benbow Dam in fair numbers from April through August 1939, with the bulk of migration occurring during the month of June.

In addition to the two runs of adult steelhead trout mentioned above, fresh sea-run individuals known as "half-pounders" also enter the Eel River in late summer. These immature steelhead, usually ranging from 10" to 15" in length, enter the fishery in the lower river from August through October. These

fish commence their upstream migration and reportedly are present in the South Fork Eel River in fair numbers after the first fall rains.

Resident Trout

The magnitude of resident trout populations in the main stem of the South Fork Eel River or its tributaries is not known. It is highly probable that the majority of "trout" taken in the summer trout fishery are actually young steelhead trout and silver salmon.

Other Species

Other species of fish known to be present in the South Fork Eel River drainage are green sunfish, brown bullhead, suckers, and three-spined sticklebacks. These fish are not actively sought by anglers and thus are considered to be of no importance to the fishery.

Distribution of Spawning Areas

The availability of suitable spawning grounds, probably more than anything else, controls the distribution of salmon and steelhead trout in the South Fork Eel River drainage. Spawning areas must provide gravel of a certain size range, and water flowing at a moderate and reasonably constant rate at favorable temperatures.

The main stream channel and tributaries above the Branscomb Dam site appear to contain some of the best spawning gravels available for silver salmon and steelhead trout in the South Fork Eel River drainage. King salmon also use this area for spawning purposes.

Salmon and steelhead spawning areas in the 17-mile section extending from the dam site downstream to the Cedar Creek State Fish Hatchery are extremely limited. In the few short stretches of riffles that do occur, the

greatest percentage of gravels overlie bedrock formations and are considered to be too shallow to be utilized successfully for spawning purposes.

The major part of the main river spawning grounds which are used by king salmon and, to an unknown degree, by steelhead trout appear to be located in the reaches of the river below Cedar Creek.

Some idea as to the areas within the drainage which are utilized for spawning purposes by the king and silver salmon can be gained by reference to the schematic map on Plate 2-C. The salmon spawning distribution portrayed on this map, which was compiled by the U. S. Fish and Wildlife Service, is based upon extensive field observations which were made by that agency during the spawning seasons of 1956 through 1958. The map does indicate, however, the extent to which the small streams in the Branscomb area are utilized by silver salmon as compared to other tributaries in the drainage.

Distribution of Nursery Areas

Despite the loss of habitat incurred through destructive logging practices in the past, the section of drainage above the Branscomb Dam site still contains some of the best nursery areas for juvenile salmonids in the South Fork Eel River drainage. The potential of this area could be developed even further through stream rehabilitation. Young steelhead trout and silver salmon were far more abundant in this area and in sections of the main stream and its tributaries within a 4-mile stretch below the dam site than in any other portion of the drainage surveyed. These small, well-shaded streams, affording good shelter, food and low water temperatures, provide the environmental conditions necessary to maintain these fish populations at a high level. Below this section of the drainage, as the channel bottom increases in width, the amount of stream shade, shelter, and the abundance of fish life decrease proportionately.

Between Ten Mile Creek and the mouth of the South Fork Eel River, very long, deep, rocky pools and long, shallow, sandy bottomed runs with frequent gravelly and sandy bars comprise the greatest percentage of the total stream length. These areas are interspersed with relatively short, broad, shallow riffles. Observations, which were made by a team of biologists skin diving with snorkel gear, revealed that very few salmonids inhabit these large pools during the late summer and early fall months. In some instances, the pools were completely devoid of any form of fish life. In others, only small populations of suckers or sticklebacks were observed. Where salmonids were present, they occurred in relatively small schools and almost without exception were concentrated in the cooler depths of pools or at points where there was an inflow of colder spring or tributary water. Temperatures in the inflowing tributaries ranged from 9° to 13° F. cooler than the main stream temperature of 77°. The large concentrations of fish in the tributaries immediately above their mouths indicated that large numbers may have ascended into these cooler waters to escape the higher water temperatures of the main river.

It was observed that in some pools where water temperatures were homogeneous, young salmonids were concentrated in the riffle or rubble-bottomed section at the head of the pool rather than in the pool itself. Inasmuch as the water temperatures usually were the same, the behavior of these fish suggested that some other factor such as water velocities, shelter, food, or more likely better aeration was responsible for their crowding into the smaller riffle areas.

Trends of Anadromous Fish Runs

Some indication as to the magnitude of the runs entering the South Fork Eel River each year can be obtained from the fish count figures presented in Table 1. These counts of upstream migrating fish have been made at Benbow

Dam each year since 1938 by personnel of the Department of Fish and Game. Although these counts are often used as a level of comparison to show the size of the South Fork Eel River fish runs, such a comparison is not adequate in scope because it does not reflect the production of these species below the dam. The counts do, however, indicate the trend of upstream production and are so used in this report.

The salmon and steelhead runs above Benbow Dam generally have declined since 1952 (Table 1). The most serious decline is evidenced in the numbers of king and silver salmon passing the dam. The average number of king salmon spawning above Benbow Dam during the period 1938-51 was 11,782. The average number of silver salmon spawning above the dam during this same period was 13,514. During the period 1952-58 the average number of kings and silvers spawning above the dam dropped to 4,376 and 4,761, respectively.

TABLE 1

ANNUAL FISH COUNTS

BENBOW DAM

Year	King Salmon	Silver Salmon	Steelhead
1938[1/]	6,051	7,370	12,995
1939	3,424	8,629	14,476
1940	14,691	11,073	18,308
1941	21,011	13,694	17,356
1942	10,612	15,037	25,032
1943	7,264	13,030	23,445
1944	13,966	18,309	20,172
1945	12,488	16,731	13,626
1946	16,024	14,109	19,005
1947	13,160	25,289	18,225
1948	16,312	12,872	13,963
1949	3,803	7,495	13,715
1950	14,357	12,050	15,138
1951	12,476	11,441	13,774
1952	7,256	3,711	19,448
1953	7,948	3,052	15,425
1954	5,406	6,016	14,000
1955	3,974	6,054	11,443
1956	1,530	5,717	12,333
1957	3,050	5,432	7,910
1958	1,472	3,344	11,984

1/ 1938 refers to counting year 1938-39, etc.

EFFECTS OF THE PROPOSED PROJECT UPON THE FISHERY RESOURCES

Probable Detrimental Effects

The immediately apparent detrimental effects resulting from construction of the project, with respect to the anadromous fisheries, would be the loss by inundation of valuable salmon and steelhead spawning and nursery grounds upstream from the dam. The majority of the other tributaries in the South Fork Eel River drainage which are utilized by silver salmon go dry throughout most of their lengths during the summer months, thus necessitating considerable fish rescue work to save the young from perishing. With so few suitable nursery areas remaining elsewhere in the drainage, the loss of the live streams in the Branscomb area would be of serious consequence.

Probable Benefits

The principal benefits which would be expected to result from the construction and operation of the reservoir would be the increased regulated flows in the South Fork Eel River below the dam during the normal low flow period, and the establishment of a fishery in the reservoir. Specifically, the benefits which may be expected to accrue to the fishery from the increased flows are as follows:

Early Entry. Allow earlier entry of king salmon and "half-pounders" into the river in dry years.

Spawning Areas. Increase king salmon spawning areas in the lower sections of the river by increasing the wetted perimeter of the channel in the fall months.

Improved Environments. Enhancement of the stream environment for juvenile and yearling salmon and steelhead (and resident trout) through increased habitat and lower summer water temperatures.

Fish Food. Enhancement of conditions for invertebrate fauna, which is important as fish food, by increasing areas of production and lowering of water temperatures.

Impediments. Eliminate "dry" sections of the South Fork Eel River and main Eel River below its confluence with the South Fork Eel River and allow unhindered upstream passage of adults. "Dry" sections are defined as those over which the depth of water is insufficient to allow unrestricted passage of fish.

Possible Enhancement Features of Project

Early Entry. It has not yet been clearly shown what benefits would be derived through providing sufficient flows to allow the earlier entry of king salmon into the South Fork Eel River during dry years. There is reason to believe that the estuarine waters actually are more favorable for these fish than if they were induced to move farther on upstream. King salmon in our coastal drainages have become physiologically conditioned to delays in entering rivers to spawn. Except in extreme conditions, these delays do not appear to seriously affect these fish. Moreover, it is problematical if increased flows alone would encourage fish to enter the river earlier. Although concentrations of salmon in the ocean and estuaries often enter and ascend rivers as soon as there is a sufficient volume of water, there is equal evidence to support the belief that this movement is triggered by temperature. Such observations have been made on the Mad River and other north coastal streams. At Benbow Dam on the South Fork Eel River, for example, concentrations of king salmon have been observed below the dam during the winter period when the water is low, clear, and cold. Although sufficient water was available for these fish to pass through the fishway, they would not ascend.

Increased flows from Branscomb Reservoir may induce "half-pounders" to enter the South Fork Eel River earlier in the fall, thus lengthening the angling season for these fish. The effect of this increased exploitation on this segment of the fishery is unknown.

Spawning Areas. Regulated flow releases below Branscomb Dam would be expected to provide an undetermined amount of additional spawning area for king salmon. In the preliminary evaluation report on the Branscomb project

by the U. S. Fish and Wildlife Service, the following statement appears with respect to spawning areas:

> "Although the proposed minimum flow would provide some additional spawning area on riffles which are presently not flooded until late in the spawning season, these areas would only be useful to early-spawning king salmon for which spawning area is already sufficient for any anticipated increase in their number."

Elsewhere, the report states:

> "... it is believed that the additional riffle areas for spawning would not compensate for any of the loss of spawning grounds above the dam."

Information compiled during the current investigations support both of the above statements.

Improved Environment. Although riffles comprise only a small percentage of the total stream bottom, the increased flooded areas would create additional habitat of this type for juvenile fish. The benefit of increased pool areas would be negligible since considerably more habitat of this type now exists than is utilized.

Fish Food. The increased flows below Branscomb Dam would enhance conditions for invertebrate bottom fauna by providing increased oxygen, increased food production areas, and lowered stream temperatures for a limited distance below Branscomb Dam. Downstream food production also would be augmented by plankton blooms in the reservoir.

Impediments. The current investigations did not establish the extent of the "dry" sections in the lower drainage that reportedly impede the upstream passage of migrant fish because of insufficient flows. Therefore, it is not possible to assess the possible benefits. Increase of downstream releases to 100 cfs by October 1 would ensure free passage of upstream migrants throughout the South Fork Eel River.

Temperature

All presently available information strongly supports the belief that high water temperatures are one of the primary factors limiting fish production in the South Fork Eel River drainage. Although quantitative data are lacking, it is believed that the loss of aquatic fish food organisms resulting from high temperatures and the extensive siltation of the streams from logging operations also has contributed to the lower level of fish productivity. If increased stream flows of sufficient volume were provided to eliminate or reduce these adverse effects of high temperatures, such flows would be highly beneficial.

Lowered water temperatures have been provided for great distances below Shasta Dam on the Sacramento River and Boulder Dam on the Colorado River. In the case of the Sacramento River, which has a mean annual flow of 12,000 cfs, the enhancement of the salmon and steelhead fisheries has been attributed primarily to the low water temperatures associated with flow releases below Shasta Dam. However, the volumes of water released below the dams on these rivers are considerably greater and are not comparable to the relatively small flows that would be provided by Branscomb Reservoir.

Present Temperature Regime

Thermograph installations have been maintained at several points in the South Fork and main Eel River by both the U. S. Fish and Wildlife Service and the California Department of Fish and Game. Nearly complete water temperature records exist for points near Branscomb and Fernbridge for the years 1957 and 1958 and for points at and near Benbow Dam for the years 1957, 1958, and 1959. In addition, there are records of instantaneous stream temperatures taken by stream survey parties of both agencies and by the California Department of Water Resources.

An examination of these data indicates that in the Branscomb area maximum water temperatures occurred during the months of July and August for the two years of record. These months appear to be the most critical, temperature wise, for salmonid fish in the South Fork Eel River drainage. Salmonids should not be subjected to water temperatures above 70° F. for any extended period. It is recognized that salmonids do survive greater temperatures than this, but such temperatures are dangerous and should be avoided if possible.

Thermograph records (Tables 2, 3, and 4) and other survey data indicate that water temperatures are tolerable for salmonid fish throughout the greatest part of the year in the reaches above, and for a short distance below the Branscomb Dam site. This is supported by the consistently great abundance of juvenile salmonids which has been observed in this section of the South Fork Eel River over a period of years.

In the vicinity of Benbow Dam, approximately 42 miles below the Branscomb Dam site, thermograph records (Tables 5 and 6) show that maximum stream temperatures of from 80° F. to 88° F. occurred for 41 days during June through September 1958. Instantaneous water temperatures recorded at various points in the main stream indicate that the temperatures recorded at Benbow generally are representative of water temperatures in the reaches of the drainage above and below the dam.

The thermograph records existing for the main Eel River at a point 1/2 mile southeast of Fernbridge (Tables 7 and 8) show water temperatures in this area to be favorable (less than 70° F.) for salmonid fish throughout practically the entire year.

TABLE 2

Water Temperatures in Degrees Fahrenheit, South Fork Eel River at Branscomb, Mendocino County, 1957
Thermograph Located on Right Bank 0.4 Mile from Jack of Hearts Creek and 4.7 Miles North of Branscomb.
(From U. S. Fish and Wildlife Records)

	July			August			September			October			November			December		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
1				74	67.2	61	68	61.8	57	62	59.3	58	50	48.8	48	43	42.3	41
2							69	62.8	58	61	57.9	56	48	46.3	45	44	42.9	42
3				75	67.4	64	69	62.7	58	58	55.5	54	46	44.5	43	43	42.1	41
4							68	62.6	57	55	53.9	53	45	43.2	42	44	42.3	41
5				68	64.3	62	69	63.8	59	54	52.3	52	45	43.1	42	46	45.2	44
6				71	64.0	60	72	65.8	60	53	51.7	51	45	44.0	43	46	45.5	45
7							74	67.2	62	53	51.8	50	45	44.1	43			
8							75	68.4	62	54	53.0	52	48	46.8	45	48	46.4	45
9							74	68.3	63	53	53.0	53				45	43.0	42
10				71	65.3	61	70	66.6	63							43	42.6	41
11				71	64.5	60	68	64.5	63	54	52.4	51						
12				72	65.0	60	68	63.7	60	52	51.3	51				43	42.8	42
13				73	66.5	62	68	64.1	60	54	53.0	52				44	43.5	43
14				74	66.8	62	68	64.3	61	53	51.4	50				45	44.5	44
15				74	66.9	62	66	63.5	62							48	46.5	45
16				73	66.8	62	64	62.0	60							49	48.1	48
17				73	66.2	61	66	61.4	58				49	48.7	48	48	48.0	48
18				73	66.2	61	64	60.7	58				50	49.5	49	49	47.8	47
19				72	65.6	61	65	60.1	56				52	51.3	50	50	49.2	48
20				72	65.3	60	64	59.6	55	51	45.6	48	53	52.2	51	51	50.2	50
21				71	65.8	61	64	59.3	55	50	48.8	47	51	48.9	46	50	49.7	48
22				73	66.5	61	65	59.9	55	50	49.1	48				49	48.4	48
23				74	67.9	63	65	60.9	57	51	50.5	50				48	47.5	47
24				74	67.8	63	64	60.4	56	51	50.8	50	47	45.9	45	49	48.6	48
25				70	65.8	63	62	59.5	56	53	52.1	51	47	46.2	45	50	49.6	49
26				70	63.8	59	62	59.5	59	53	52.2	51	47	46.1	45			
27	77	69.8	65	68	62.2	58	60	59.3	59	52	50.8	50	45	44.3	43			
28	77	70.4	65	68	61.8	57	59	57.9	57	52	50.3	49						
29	75	69.5	65	67	62.1	58	59	57.3	56	50	48.7	47						
30	74	67.8	63	68	62.5	58	61	58.3	57	49	48.3	47				48	48.0	48
31	73	66.9	62	67	61.5	57				51	49.5	48						

TABLE 3

Water Temperatures in Degrees Fahrenheit, South Fork Eel River at Branscomb, Mendocino County, 1958. Thermograph Located on Right Bank 0.4 Mile from Jack of Hearts Creek and 4.7 Miles North of Branscomb. (From U. S. Fish and Wildlife Records)

	January			February			March			April			May			June		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
1				51	49.7	48	51	48.1	46	47	45.8	45	60	57.4	53	61	60.1	50
2				50	49.6	49	50	48.1	46	47	45.6	45	60	57.0	53	60	58.7	58
3				49	48.8	48	50	48.0	46	47	45.9	45				60	58.1	56
4				50	49.6	49	51	48.4	46				61	57.5	53	64	57.0	60
5	46	45.1	44	51	50.5	50	50	49.0	48				61	58.0	54	65	62.1	59
6	46	45.3	44	51	51.0	51	49	46.6	46	49	46.3	44	61	57.8	54			
7	46	45.3	44	52	51.3	51	46	44.4	43	51	47.8	45	61	58.0	54			
8	48	46.6	46				47	45.2	44	51	48.1	46	62	58.9	55	61	59.3	58
9	48	47.8	46	51	50.8	50	48	45.3	43	52	49.4	47	63	59.6	56	59	58.5	58
10				52	51.1	50	46	44.6	44	54	50.6	47	60	58.4	57	62	59.4	57
11				52	51.5	51	46	44.6	43	55	50.5	48	57	56.0	55	66	62.3	60
12	50	49.2	49	52	51.3	50	47	45.5	44	53	51.0	49	58	55.3	52	65	61.8	60
13	50	49.3	48	51	50.3	49	46	44.4	43	53	51.0	49	60	56.3	53	67	63.0	59
14	50	49.7	49	52	50.6	50	45	43.6	43	56	52.1	49	61	57.7	54			
15	50	50.0	50	53	52.1	52	49	44.8	43	55	52.1	49	63	59.8	56	72	67.7	64
16	51	49.9	49	54	52.6	52	48	45.7	43	55	51.8	49				73	68.8	65
17	51	49.4	47	53	52.4	52	48	46.1	44	52	50.7	50				72	68.6	66
18				52	52.0	52	48	45.9	44	57	53.2	50				69	66.9	65
19	48	46.9	46	52	52.0	52	48	46.0	43				65	62.1	60	68	65.1	63
20	48	47.4	47	54	52.5	51	48	46.6	47	57	53.7	50	66	62.7	60			
21	47	46.4	46	54	52.3	51				58	53.0	51	66	63.0	60			
22	47	46.5	45	52	51.0	50				56	53.1	51	62	60.5	58	72	68.4	66
23	47	46.3	45	53	52.3	52	48	47.4	47	54	50.9	48	61	57.0	59	68	66.2	65
24	49	48.6	57	53	51.9	51	48	47.3	47	54	50.8	47	60	58.3	57	71	66.7	64
25	50	48.6	48	51	50.2	50	49	47.4	46	55	51.6	48	65	61.1	58	73	67.7	63
26	51	49.7	49	51	49.8	49	50	47.8	45	55	55.8	48	65	62.1	49			
27	50	49.0	48	50	49.2	48	50	48.3	47	55	52.1	49	62	60.3	59			
28	52	51.0	50	50	48.5	47	49	48.3	48	57	53.3	49	64	60.4	57			
29	52	51.5	51				47	46.2	45	58	55.0	51	66	62.3	59	71	66.2	62
30	51	50.3	50				47	45.8	45	59	55.9	52				70	65.2	61
31	51	49.7	49				48	46.8	46									

TABLE 4

Water Temperatures in Degrees Fahrenheit, South Fork Eel River at Branscomb, Mendocino County, 1958.
Thermograph Located on Right Bank 0.4 Mile from Jack of Hearts Creek and 4.7 Miles North of Branscomb.
(From U. S. Fish and Wildlife Records)

	July			August			September			October			November			December		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
1	68	64.5	62															
2	72	66.3	62															
3																		
4																		
5																		
6	78	72.1	67															
7	78	72.0	67															
8	78	71.8	67															
9	77	71.3	66															
10	78	71.7	66															
11	78	71.6	66															
12	78	71.8	67															
13	77	71.8	67															
14	76	70.7	67															
15	72	63.6	65															
16	69	65.5	64															
17	71	66.2	62															
18	74	68.8	64															
19	76	70.6	66															
20	76	71.0	67															
21	76	71.9	69															
22																		
23																		
24																		
25																		
26																		
27																		
28																		
29																		
30																		
31																		

TABLE 5

Water Temperatures in Degrees Fahrenheit, South Fork Eel River, Benbow Dam, Humboldt County, 1958. Thermograph Located on Left Bank at Benbow Dam Counting Station. (From U. S. Fish and Wildlife Records)

	January			February			March			April			May			June		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
1	48	46.6	46	49	48.1	48	51	49.4	48	56	56.0	56	62	59.4	58			
2	48	47.1	46	49	48.2	48	50	48.5	48	56	55.6	55	62	60.3	59			
3	46	46.0	46				50	48.3	48				62	60.4	59			
4	46	44.8	44	49	48.3	48	50	48.0	46									
5	44	43.8	43	50	48.2	48												
6	44	43.3	42	50	49.1	48	48	45.8	44									
7	44	43.9	43	50	50.0	50	46	44.3	44				70	63.3	60			
8	46	45.3	44	50	50.0	50	46	44.9	44				71	64.6	60			
9	46	45.8	45	51	49.6	48	48	45.4	44				72	65.4	62			
10	48	47.4	46	50	49.1	48							64	62.8	61			
11	48	48.0	48	52	51.3	50	48	46.7	44				60	59.3	56			
12	48	47.3	46	52	50.3	49	48	46.5	46				66	59.4	55	70	66.0	64
13	46	46.0	46	48	48.0	48	47	45.2	44				68	61.2	56	74	67.1	62
14	48	47.3	46	50	48.6	48	46	44.3	44				70	62.8	58	76	69.8	64
15	50	48.3	48	51	50.6	50	50	46.1	44				72	65.2	60	80	73.3	66
16	49	48.3	48	52	51.4	50	50	46.7	44	58	55.4	53	76	67.8	68	82	75.0	70
17	50	48.8	48	52	51.7	51	50	46.8	44	54	53.4	53	73	68.1	64	80	74.2	70
18	49	47.7	46	52	52.0	52	48.4		46	60	54.8	52	73	67.4	64			
19	46	45.3	44	52	51.5	50	52	48.5	46	60	56.1	54				74	69.2	66
20	46	45.3	44	52	50.8	50	49	48.2	48	62	57.3	54				78	71.8	68
21	47	45.4	44	52	51.3	50	50	48.1	47	62	57.8	54				80	72.9	68
22	44	43.7	43	52	51.8	51	48	47.7	47	58	56.4	54				80	72.6	68
23	44	43.1	42	50	50.0	50	48	47.3	46	56	53.9	52				77	71.9	68
24	46	45.3	44	52	51.4	51	48	47.0	46	56	53.7	52				80	73.2	68
25	48	47.0	46	52	51.0	50				57	54.3	52				81	73.7	68
26	48	47.0	46	50	50.0	50	50	49.8	49	60	55.3	52				78	72.4	69
27	48	47.2	46	50	49.1	49				60	55.3	52				78	70.5	66
28	50	49.4	48	50	49.3	48				58	54.7	52				76	69.2	64
29	51	50.3	50				48	47.4	46	60	54.3	56				75	68.7	64
30	50	48.8	48				56	56.0	56	62	58.8	56				76	69.2	64
31	49	48.1	48				57	56.3	56									

TABLE 6

Water Temperatures in Degrees Fahrenheit, South Fork Eel River, Benbow, Humboldt County, 1958.
Thermograph Located on Right Bank 2 Miles Upstream from Benbow Dam at Parkinson's Motel
(From U. S. Fish and Wildlife Records)

	July			August			September			October			November			December		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
1	74	70.5	67	88	80.6	74	80	74.2	70	74	67.6	63	58	55.8	54	46	45.4	44
2	80	72.9	68	86	79.9	76	78	71.9	68	74	67.3	62	60	57.1	56	50	47.4	46
3	82	74.4	68	84	76.6	72	76	70.4	66	72	66.4	62	58	57.3	56	51	49.2	48
4	84	76.6	70	84	76.3	70	78	71.8	66	70	65.8	62	60	58.9	58	50	48.6	48
5				86	77.7	71	80	73.7	68	70	64.9	62	61	59.3	58	49	47.8	46
6				86	77.8	72	74	71.6	70	66	62.9	60	62	60.0	58	48	47.8	47
7				85	77.8	72	71	69.4	66	67	62.3	59	62	59.8	58	49	47.7	46
8							74	69.3	66	66	62.5	59	62	59.3	58	48	47.8	47
9							74	69.3	66	68	63.4	60				50	49.0	48
10										69	63.4	60				51	50.1	50
11										68	62.8	60				51	49.9	49
12							68	66.2	64	68	62.8	59	54	51.4	50	52	49.9	49
13							70	66.3	64	68	62.8	60	52	50.5	50	50	49.2	48
14							72	66.8	62	66	62.2	58	52	51.1	50			
15							74	68.9	64	68	62.8	58	51	49.5	48			
16	74	70.4	68	80	75.9	72	74	69.0	66	66	61.9	59	48	46.0	43	49	48.1	48
17	76	71.3	68	80	75.8	73	73	68.5	66	62	60.5	59	41	41.9	40	48	47.4	46
18	73.9		68	86	77.6	72	72	67.3	63	62	61.1	60				46	46.0	46
19	84	75.6	69	86	78.3	74	72	66.8	64	62	59.9	58				48	47.7	46
20				86	78.6	73	72	66.2	62	60	57.1	54						
21	82	75.3	72	86	79.5	74	72	66.1	62	60	56.8	54						
22	80	75.6	70	86	79.5	74	64	61.8	60	58	54.9	53						
23	82	75.3	70	84	78.4	74	66	61.0	58	57	53.3	50						
24	84	76.8	71	85	78.3	73	66	61.0	56									
25				86	78.1	72	68	62.1	57				51	49.9	49			
26				86	77.8	72	72	65.3	60				52	50.4	50			
27				85	76.8	72	74	67.1	62				50	48.7	48			
28				82	75.2	71	73	67.3	62				49	47.7	47			
29				80	74.1	70	74	68.3	64	59	55.8	54	47	46.0	45			
30	86	78.6	72	81	74.9	70	74	68.3	64	56	54.1	52	47	45.4	44	46	44.8	44
31				84	76.4	71				55	54.3	53				46	44.9	44

TABLE 7

Water Temperatures in Degrees Fahrenheit, Main Eel River, Fernbridge, Humboldt County, 1958.
Thermograph Located on Right Bank 1/2 Mile Southeast of Fernbridge.
(From U. S. Fish and Wildlife Records)

	January			February			March			April			May			June		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
1										46	45.6	45	59	58.3	57	66	65.0	64
2										45	45.0	45	62	59.7	58	65	64.5	64
3										46	45.2	45	63	60.1	58	69	65.3	62
4										48	46.1	45	64	60.9	59	69	66.2	63
5										47	46.6	46	60	59.3	59	69	67.0	65
6										48	46.1	44	63	59.6	57	69	67.3	66
7	43	43.0	41										60	59.0	58	69	66.6	65
8	45	43.4	42							51	49.6	49	64	60.3	58	68	66.3	64
9	46	44.9	43							52	51.1	49	64	61.9	60	67	65.7	64
10	47	46.1	46							55	52.3	50	62	61.3	61	70	66.9	64
11	46	45.4	45							57	53.9	52	60	57.9	55	68	66.3	65
12	46	45.8	45							56	53.9	52	60	57.5	54	68	65.1	63
13	45	45.0	45				50	48.3	47	53	52.6	52	62	58.9	56	69	66.3	64
14	45	45.0	45				48	47.3	47	56	53.4	51	65	61.4	58	70	67.4	65
15	47	46.0	45				51	48.4	46	56	53.8	52	68	64.3	61	72	69.4	67
16	48	46.8	46				51	48.7	47	56	54.5	53	66	64.6	63	73	70.3	68
17	48	47.6	47				51	48.9	47	54	53.5	53	68	64.9	62			
18	48	46.8	45				52	49.7	47	57	53.8	52	68	65.6	64	69	68.1	67
19	45	44.7	44				52	50.4	48	57	54.8	53	68	65.7	64	69	67.6	66
20	45	44.4	44				52	51.0	50	59	55.8	53	66	65.0	64	70	68.5	67
21	46	44.5	44				51	48.7	48	57	55.9	55	66	64.8	64	71	69.3	68
22	45	43.8	43				48	47.4	47	57	55.4	55	65	63.8	63	69	68.5	68
23	44	43.4	43				49	47.4	46	56	53.3	52	68	64.9	63	69	68.2	67
24	46	44.8	44				48	47.4	47	56	53.1	51	66	64.6	63	70	68.9	68
25	45	44.6	44				49	47.4	46	57	54.2	52				70	68.8	68
26	45	44.3	44				50	47.8	46	57	54.5	52				69	67.9	66
27	46	44.9	44				52	49.5	48	57	55.1	53	69	67.3	65	68	65.6	64
28	47	46.6	46				51	49.8	49	60	56.8	54	70	67.1	64	68	65.6	64
29	48	47.3	47				49	47.8	46	63	58.2	56	69	66.9	65	67	65.3	64
30							46	45.2	45	63	60.2	56	67	66.1	65	67	65.6	64
31							46	45.6	45				69	66.2	64			

TABLE 8

Water Temperatures in Degrees Fahrenheit, Main Eel River, Fernbridge, Humboldt County, 1958
Thermograph Located on Right Bank 1/2 Mile Southeast of Fernbridge
(From U. S. Fish and Wildlife Records)

	July			August			September			October			November			December		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
1	69	67.5	66	73	69.8	68				67	63.9	61	59	57.8	57			
2	69	67.3	66	70	68.3	67				67	63.9	62	60	58.7	57			
3	69	67.5	66	70	67.1	65				66	64.0	62						
4	71	68.8	65	71	67.9	66				64	63.0	62	61	60.4	60			
5	71	69.3	68	70	67.4	66				62	61.8	61	61	60.3	60			
6	69	68.4	68	67	66.2	65				62	60.9	60	62	61.1	60			
7	69	67.8	67	69	66.3	64				64	60.9	58	64	62.4	61			
8	68	67.2	66	70	67.4	66				63	60.3	58	64	62.3	61			
9	68	66.8	66	69	66.7	65	69	66.5	65	63	60.6	59	62	60.5	58			
10	69	66.9	65	68	66.3	65	67	65.1	64	63	60.7	59	59	56.9	54			
11	69	67.4	66	70	66.9	65	69	65.6	63	62	59.9	58	54	53.0	52	57	55.8	54
12	70	67.5	66	70	66.9	65	66	64.7	63	62	60.4	58	54	52.6	52	59	57.3	56
13	69	67.1	65	70	66.8	65	67	64.6	63	64	61.4	59	52	51.5	51	56	54.6	54
14	66	65.2	65	69	66.9	65	69	65.5	63				51	48.6	46	54	52.9	52
15	68	66.8	65	69	66.8	65	70	66.8	64	62	59.9	58	46	44.8	43	55	53.4	53
16	66	65.8	65	67	65.7	65	69	67.2	66	62	59.8	58	43	42.2	41	54	53.2	53
17	67	66.3	65	66	65.0	64	69	66.0	64	60	59.5	59	42	41.8	41	54	53.1	52
18				69	66.2	64	69	65.6	64	61	59.8	59	43	41.8	41	55	53.8	53
19	67	65.2	65	68	66.2	64	69	65.4	63	61	59.2	58	44	43.8	43	55	54.1	53
20	66	65.3	64	69	66.0	64	68	63.4	61	60	57.8	56	46	44.6	43	55	54.4	54
21	69	66.3	64	72	67.8	64	66	62.5	60	60	57.5	55	47	45.8	45	56	54.1	54
22	68	66.8	66	73	69.4	67	63	61.2	60	57	56.2	56	46	45.3	45	52	51.0	50
23	68	66.2	65	70	68.3	66	63	59.8	58				45	44.1	43	51	50.2	50
24	69	67.0	65	71	67.4	66	63	59.7	56				46	45.3	44			
25	71	68.4	67	71	67.7	65	65	61.0	57	57	55.8	54	47	46.0	45			
26	71	68.4	67				67	63.2	60	58	56.3	55	47	46.3	45			
27	70	68.3	67				69	64.8	61	58	56.9	56	48	46.5	46			
28	70	68.5	67				68	64.5	62	59	57.3	56	47	45.2	44			
29	70	68.2	67				68	64.3	62	59	56.8	55	44	43.9	42			
30	68	67.5	67	72	67.9	66	67	63.8	62	57	56.1	55	43	42.8	42	52	51.8	51
31	71	68.6	67	71	67.4	65				57	56.6	56				53	51.7	50

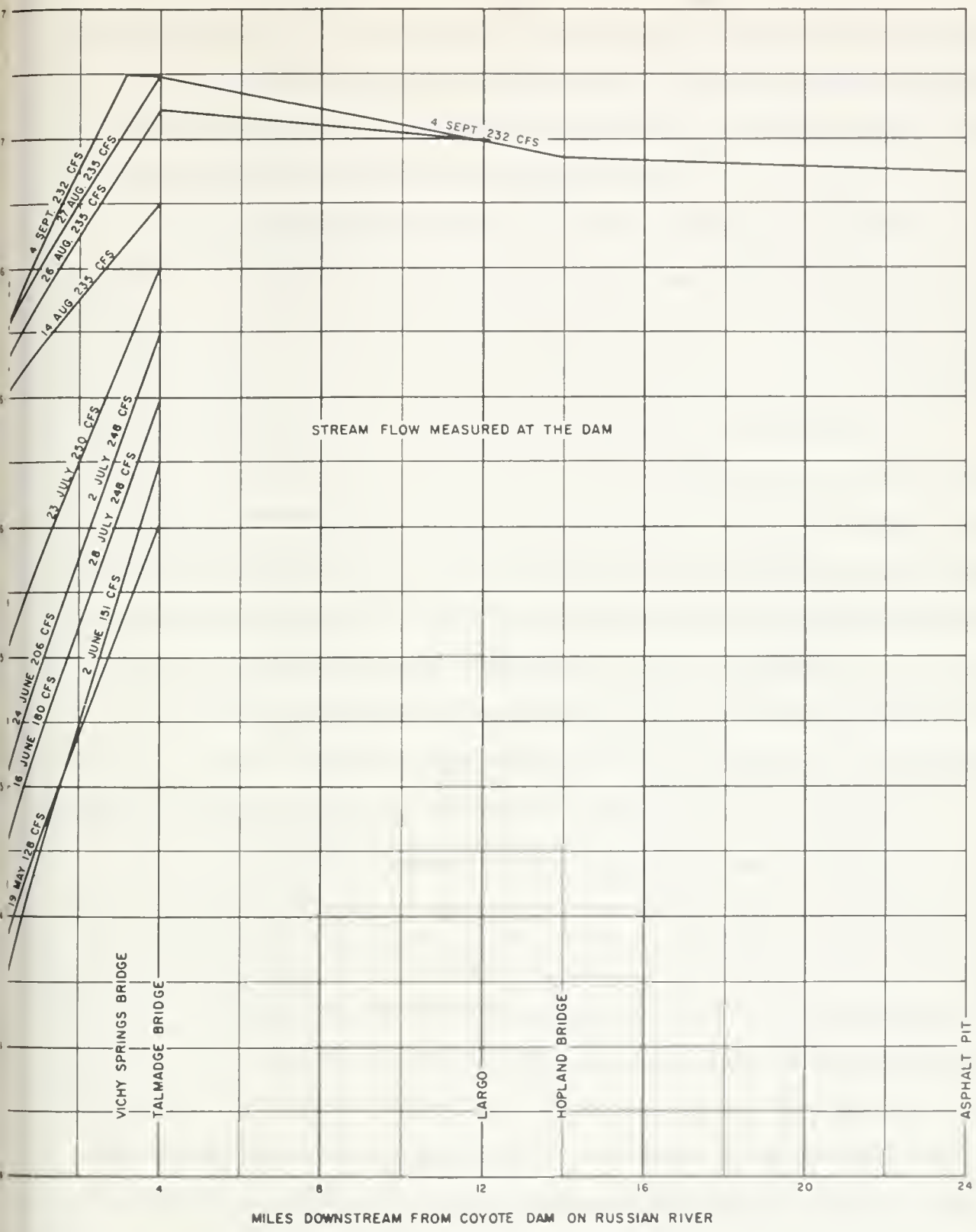
Forecast of Changes After Project Development

Sufficient data are not presently available to permit a definitive prediction of the changes in the water temperature regime that would take place within the Branscomb Reservcir and in the stream below after project construction. However, the existing temperature data available for the Russian River below the newly completed Coyote Dam have been drawn upon to obtain a general idea of changes that might be expected. Although the apparent differences in physiography are recognized, it is believed that sufficient similarity of climatic and physical characteristics exists to permit a valid comparison of temperature regimes.

Russian River. Temperatures were taken several times each month from May through September 1959, at two stations below the dam. The uppermost station immediately below the dam outlet; the lower station was 4 miles below the dam at the Talmadge road bridge. Temperatures also were taken periodically at other points. Since these stream temperatures were recorded at various times of the day, sometimes in the early morning, they do not necessarily reflect the maximum temperatures that occurred at the lower stations.

The stream temperature data are shown in Figure 1, together with corresponding stream flows recorded at the U. S. Geological Survey gaging station below the dam. From this figure it is apparent that considerable variation in water temperatures occurred over a very short distance at flows ranging from 128 to 250 second-feet. Temperature increases of 12° F. within a 4-mile reach below the dam were common. The value of irregular temperature observations as a basis for determining the stream temperature variations is obviously limited. However, they are the only data available.

Of particular interest are the variations shown in Figure 1 for August 27 and September 4, 1959. On September 4, for example, the water left



RUSSIAN RIVER TEMPERATURE CHANGE BELOW COYOTE DAM

Coyote Dam with a temperature of 66° F. (3:30 p.m.). At a flow of 232 second-feet, the temperature rose to 74° F. (3:45 p.m.) 3 miles downstream at the Vichy Springs road bridge. A reading of 71° F. was recorded later in the afternoon (5:00 p.m.) at a point 24 miles below the dam. This temperature pattern indicates a high degree of solar radiation absorption, with water temperatures increasing sharply within a very short distance and then stabilizing or decreasing according to air temperatures and/or the effects of the sun's rays.

The Department of Water Resources Bulletin No. 65, "Quality of Surface Waters in California", shows the water temperature at a sampling station, also located upstream from the Talmadge road bridge, to be 71° F. (12 noon) on September 11, 1956, (before completion of Coyote Dam). The stream flow at this point was approximately 200 second-feet according to U. S. Geological Survey records. The implication here is that present water temperatures, even at flows in excess of 200 second-feet, are much the same as they were prior to impoundment and release of waters from behind Coyote Dam.

Inasmuch as the difference between air temperature and water temperature is perhaps the primary cause of changes in water temperature, it is necessary that air temperature data, along with flow, be studied when analyzing changes in water temperatures. Because of the complexity of the subject and the time limitation, it is beyond the scope of this report to establish the correlation between the climatic conditions of the Ukiah area and the South Fork Eel River drainage. It also is recognized that factors other than air temperatures, such as volume and depth of flow, tributary streams, inflow of ground water, etc., will affect stream temperatures and should be considered. However, on the basis of the material that was assembled and briefly studied, there is

reason to assume that the same degree of absorption of solar radiation occurring in waters of the Russian River below Coyote Dam also would prevail in the South Fork Eel River particularly in the middle and lower reaches that are prominently exposed to the sun for distances of 75 miles or more.

South Fork Eel River. It has been expected that benefits would accrue to the fishery because of decreased temperatures resulting from controlled flow releases from a dam constructed in the Branscomb area. On the basis of the current investigations, the distance downstream that water temperatures would be reduced by releases from the bottom of the reservoir is not certain. The stream is heavily shaded for some distance below the dam site. In addition, increments from tributaries, such as Elder Creek, are of low temperature tending to aid in maintaining low water temperatures. Depending on water temperatures in the reservoir, suitable summer water temperatures should be maintained for 5 to 10 miles below the dam.

Improved summer water temperatures in the stream immediately below the dam could result in its utilization by juvenile steelhead trout and silver salmon for a nursery area. How many fish it would support is not known. It would be used to some extent, especially by late downstream migrants.

Branscomb Reservoir. Temperature studies of existing north coastal reservoirs (Mendocino and Pillsbury) indicate that conditions approach the upper limits of tolerance for trout populations during the summer months. Angling success is not especially high when this condition persists. There is little reason to expect different temperatures in Branscomb Reservoir.

The trout fishery in the reservoir would probably be average during the early spring and late fall, and very poor during the summer months. The fact that Branscomb Reservoir would have an average depth of about 30 feet from June through October would preclude any large amount of cold water in the

bottom of the basin. This general shallowness of the reservoir would, however, provide oxygen-bearing water over the reservoir bottom most of the time, allowing the production of invertebrate fish food organisms in bottom materials. In deep reservoirs, oxygen deficiency in lower levels of water usually precludes such production. It would be expected, however, that the frequent drawdowns of water levels in Branscomb Reservoir would curtail food production in the littoral zone.

A reduction in flow releases below the dam to create a larger impoundment for the enhancement of the reservoir fishery, would adversely affect the stream fishery. Conversely, increased summer stream flows would be detrimental to the reservoir fishery.

In regard to the establishment of a warmwater fishery in the reservoir, the introduction of warmwater species into a drainage that principally supports salmonid fish populations is not desirable in view of the predation and competition for food and habitat that could be expected.

It has been expected that fisheries benefits of the proposed project would greatly overshadow minor spawning and nursery area losses caused by the project. Unfortunately, these areas above the Branscomb Dam site proved to be more extensive than generally believed. Although inconclusive, the results of the study failed to indicate greater fisheries benefits than detriments. Additional study would be required to reach a definite conclusion.

In any event, a considerable number of adult fish could be expected to concentrate below Branscomb Dam in their attempt to reach spawning areas which would be blocked off following the dam construction unless fish passage facilities were provided. It is evident, therefore, that the incurred loss in fish production, as well as the public relations aspect, would require that some provision be made for fish-maintenance facilities at this point. Although

several methods of fish maintenance to perpetuate the anadromous runs will be considered briefly in this section, a more comprehensive study will be required when specific project data are available and more precise information as to the magnitude of the anadromous fish runs above Branscomb is obtained.

The possibility of constructing artificial spawning channels below the dam also has been considered. An examination of the stream sections below the dam site revealed no satisfactory area where such channels might be constructed. Since no gravels occur naturally in the stream bed immediately below the dam site, they would have to be brought in from elsewhere in the drainage.

The only alternative plan that suggests itself, other than passing fish around the dam, appears to be that of confining the migratory fish to the area immediately below the dam and to propagate artificially all fish that normally would have migrated beyond the dam site. A site that might be developed for a hatchery installation exists a short distance below the dam site. However, the feasibility of such an installation would be almost completely dependent upon the quality of water issuing from the reservoir or the development of another source. Further study would be required to determine the feasibility of this installation.

Fish Passage Facilities

Any plan of fish maintenance that provides for continued spawning in the area above the reservoir would have the advantage of utilizing natural spawning and rearing areas that otherwise would be lost permanently. Facilities that would allow the passage of upstream migrating adults and their downstream migrating progeny undoubtedly could be incorporated in the design of the dam.

In order to successfully pass migrants over the dam, a fish ladder capable of adjustment in level of 10 feet at its entrance into the reservoir

would be required. It could extend downstream parallel to the spillway which would discharge into the river about 1,200 to 1,500 feet downstream from the base of the dam. The ladder should consist of a series of pools 6 feet wide, 6 feet deep, and 8 feet long. The drop from each pool should not exceed 1 foot. Having the bottom of the ladder adjacent to the spillway would insure attraction of the upstream migrants.

During the early part of the upstream migration period the reservoir level would be below the reservoir entrance of the fish ladder. In order to supply water in the ladder it would be necessary to pump water into it from the reservoir. As soon as the water surface level of the reservoir reached the level of the fish ladder pumping could be stopped. This time would depend on the time of the first sizable fall rain.

Salmon and steelhead have refused to use the fish ladder at the Pelton Dam when water being released from the bottom of the dam was appreciably colder than surface water released down the ladder. Therefore, water pumped into the ladder should come from the lower levels of the reservoir.

Downstream migrants pose the most critical problem. Assuming, however that they would be able to negotiate the reservoir successfully, there should be no particular difficulty in getting them over the dam.

Indications are that most of the downstream migration of fish from the Branscomb area takes place during April, May, and June. During this time the reservoir would be full most years and the water surface would be within 10 feet of being full all years. This amount of fluctuation could be taken care of in the fish ladder entrance adjustment. As much spill as possible should be confined to the fish ladder. Any excess should be released from the outlet in the dam rather than down the spillway. This procedure would minimize injuries to the fish passing over the dam.

During the late summer and fall months, when the dam was not full, the only available exit from the reservoir for downstream migrants would be the outlets in the dam. Although experiments in the Northwest indicate that they will sound more than 100 feet, not many of the fish would be expected to sound that deep. This problem would probably not be serious because downstream migration is believed to reach its lowest point during the late summer and fall months.

Spill during the winter months that could not be accommodated through the outlets of the dam or down the fish ladder would present a hazard to downstream migrants. The design of the spillway could be modified to reduce this hazard. For instance, the shape of the bottom of the spillway could be curved, or V-shaped, or shaped as a modified trough to provide depth to the water. This type of modification would reduce injuries from abrasions. Manipulation of the outlet gates in the dam should help avoid very low flows over the spillway. Low flows in the spillway are especially undesirable because of the abrasive action on the fish. The spillway discharge should fall free into a large deep pool.

Minimum Stream Flows

Measured immediately below the confluence of the South Fork Eel River and Rattlesnake Creek, minimum stream flows would be 50 cfs from May 1 through September. Releases at the dam, however, should not drop below 25 cfs at any time.

Releases of 25 cfs should be made through the fish ladder from April 1 through June to facilitate downstream migrant passage. Water temperatures should be suitable for salmonids during this period, and the cooler water in the bottom of the reservoir would be saved for release during the period of July 1 to October 1.

CONCLUSIONS

The investigation and evaluation of the proposed Branscomb Project failed to demonstrate that fisheries benefits would exceed detriments. Results of the investigation were inconclusive and important questions remain to be answered. However, the following conclusions can be drawn from the current investigation:

1. More intensive study will be required before the project can be evaluated conclusively.

2. The availability of suitable spawning grounds controls the distribution of salmon and steelhead trout in the South Fork Eel River drainage.

3. The main stream channel and tributaries above Branscomb Dam site contain some of the best spawning gravels available for silver salmon and steelhead trout in the South Fork Eel River drainage.

4. The inundation of spawning areas above Branscomb Dam site would be a definite project detriment.

5. The major spawning grounds of the king salmon are located below Cedar Creek.

6. King salmon spawning areas would be increased to some extent. The amount of increase, although not known, is not believed to be significant.

7. Increased downstream flows would make early entry of anadromous fish runs possible. Whether or not this early entry would be a benefit is not known.

8. Downstream releases of 100 cfs by October 1 of each year would probably improve, to an unknown degree, free passage of upstream migrants throughout the South Fork Eel River below Branscomb Dam. This free passage would be of particular benefit to king salmon. It would be of less importance to steelhead trout since their migration period usually coincides with high water conditions.

9. High water temperature is one of the primary factors limiting fish production in the South Fork Eel River drainage. Present temperatures severely limit nursery areas for steelhead trout and silver salmon.

10. Improved summer water temperature in the South Fork Eel River could result in its utilization as nursery area for juvenile steelhead trout and silver salmon.

11. The effect of stream flow releases from Branscomb Dam on stream water temperature requires more study. However, suitable summer water temperature is expected to be created for a distance of 5 to 10 miles below the dam. Unless temperatures are reduced over a considerably greater distance downstream the value would be doubtful.

12. Minimum stream flow releases of 50 cfs from May 1 through September and 100 cfs for the remainder of the year would result in downstream enhancement. The amount of enhancement is unknown. It might be enough to compensate for the loss of spawning grounds inundated by the reservoir. The value, to a great degree, would depend on the extent of downstream temperature reduction during the summer months.

13. Suitable upstream and downstream fish passage facilities over the dam would be necessary. Without passage facilities detriments to the fishery would be greater than benefits.

14. The reservoir fishery would be mediocre at best. It would be poorest during the summer months.

15. This study indicates benefits would approximate losses and therefore little would be gained from the project. Further study would be necessary to demonstrate clear overall benefit to fish resources.

RECOMMENDATIONS

This report has emphasized the need for further study of the effect of the Branscomb Dam on the fisheries of the South Fork Eel River. On the basis of the present study it is impossible to predict the effect of the dam on the fisheries. Therefore, the following study program is recommended.

1. A temperature study be initiated below an existing dam in the north coastal or other area where conditions comparable to the South Fork Eel River exist. This could be accomplished by installing thermographs in the river at the outlet of the dam and at points downstream. It would be desirable to experimentally vary discharges from the dam during representative periods of the year so as to determine the optimum flows required to achieve the benefits of low stream temperatures in the South Fork Eel River.

2. A temperature study be made of existing reservoirs whose characteristic would be comparable to the proposed Branscomb Reservoir. This study would necessitate periodic vertical temperature profile readings at representative points within the reservoir.

3. Further study be given to the correlation of the climatological data existing for the South Fork Eel River drainage and the areas in which the thermal studies were conducted. This study should include other factors that would affect absorption of solar radiation and influence stream temperatures (inflow from tributary streams, entrance of ground water, etc.).

4. Enumeration of resident and juvenile anadromous fish populations be conducted throughout the reaches of the river below Branscomb during the spring, summer, and fall months. The method of enumeration should be such that comparable studies could be conducted after project development.

5. Enumeration of juvenile anadromous and resident fish populations be conducted in the area above the proposed dam site. This would involve trapping to determine downstream escapement of juvenile populations and subsequent enumeration of the standing population. This study to be initiated as soon as spring flows allow trapping, and continued periodically through the summer and fall months.

6. Enumeration of spawning populations be conducted in the Branscomb area. This would involve tagging, carcass counting, and periodic visual ground and aerial surveys during the spawning season.

7. Surveys be conducted to determine the extent of "dry" sections in the South Fork Eel River and main Eel River that reportedly hinder upstream passage of anadromous runs.

8. All enumeration studies be conducted in such a manner that would allow an evaluation to be made in terms of monetary benefits. This also would apply to angler-use data.

9. Further study be given to the implementation of fish-maintenance facilities at the Branscomb Dam site.

10. Further study be given the possibility of increased flows increasing existing king salmon spawning areas in the lower drainage. This could be achieved by measurement of wetted perimeters at varying flows and by measurement of the relationship between stream flow and salmon spawning areas.

Based on information available at this time, the following measures are recommended for the project considered in this report.

1. The maximum storage level of any dam constructed on the Branscomb site should not exceed elevation 1,531 feet.

2. The minimum pool should be maintained at 6,000 acre-feet.

3. A fish ladder should be provided.

4. The final design of the fish ladder should be worked out with and approved by Department of Fish and Game fisheries personnel.

5. Provision should be made to insure the normal operation of the fish ladder through a 10-foot reservoir fluctuation.

6. Pumps should be installed to supply 25 cfs. of water from the bottom of the reservoir to the fish ladder when the reservoir level is below the ladder entrance during the upstream migration period. This would be from October 1 until fall rains had raised the reservoir water level to the ladder entrance.

7. Outlets, capable of releasing 200 cfs. of water, should be provided low on the dam.

8. The spillway should be designed to minimize injury to downstream migrants.

9. Releases and spill should be contained in the ladder and outlets other than the spillway from April 1 through June.

10. Releases should be made from the lowermost outlets on the dam from July 1 through September.

11. Minimum stream flows maintained immediately below the confluence of Rattlesnake Creek with the South Fork Eel River should be 50 cfs. from May 1 through September and 100 cfs. the remainder of the year. However, releases at the dam should not be below 25 cfs. at any time.

SUMMARY

The Department of Water Resources is studying the feasibility of constructing a stream-flow maintenance dam on the South Fork Eel River near the community of Branscomb. The purposes of the project are to provide controlled flows for enhancement of the fishery and recreation. Stream flows of approximately 50 cfs. from May 1 through September and of 100 cfs. for the remainder of the year would be provided at the mouth of Rattlesnake Creek.

The limited investigation conducted by the Department of Fish and Game failed to indicate that fisheries benefits of the project were greater than the detriments. Further investigation will be required before a conclusive evaluation of the project can be made.

The major fish populations that would be affected by the project are king salmon, silver salmon, and steelhead trout. The river supports runs of these fish each year.

Salmon and steelhead runs in the upper drainage have declined since 1952. King salmon and silver salmon runs have experienced the most serious decline.

Surveys conducted by the California Department of Fish and Game and the U. S. Fish and Wildlife Service show some of the most valuable silver salmon and steelhead spawning areas exist above the proposed dam site.

About 9.3 miles of stream bed would be inundated by the dam. In all about 46 miles of river and tributaries would be blocked. Fish passage facilities would be essential.

Surveys conducted during 1959 indicated very few juvenile salmonids inhabit the main channel of the South Fork Eel River during the summer and fall. High temperatures are believed to be a major limiting factor.

Available temperature records indicate temperatures are favorable for salmonid populations in the Branscomb and Fernbridge areas and generally unfavorable throughout the rest of the drainage during the summer months.

The extrapolation of temperature data from the Russian River drainage indicates that temperature benefits which would accrue to the fishery of the South Fork Eel River at flows of 100 cfs. to 250 cfs., would extend up to 10 miles below the Branscomb Dam. Fish life and invertebrate bottom fauna would benefit from reduced temperatures and increased flows in this section.

Downstream benefits would be limited to improved summer water temperature for a comparatively short distance below the dam, and improved main stem spawning and migration conditions. Upstream detriments would consist of the loss of important spawning areas. Indications are that downstream benefits might compensate for upstream detriments. However, so many important factors are undetermined a major study should be undertaken to determine the effect of the project on the fisheries of the South Fork Eel River.

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APPENDIX D

APPLICATIONS TO APPROPRIATE WATER FROM THE SOUTH FORK EEL RIVER AND TRIBUTARIES

Application number	Name of applicant	Source	Location of point of diversion: ¼	¼	Sec.	Township	Range	Meridian	Amount: Second-feet	Gallons per day	Purpose*
3921	Division of Beaches and Parks	U* Creek	NE	NW	12	2S	2E	HM		2,100	D
4413	Benbow Hotel Co.	East Branch Eel River	SE	NE	36	4S	3E	HM	1.27		Ir,D,R
		South Fork Eel River	SW	SW	31	4S	4E	HM			
			SW	SE (Lot 2)	36	4S	3E	HM			
			SW	NE	2	5S	3E	HM			1,054.74 acre-feet storage
5274	Owners Madrona Rest Summer Homes	U* Spring	NE	NE	10	3S	3E	HM		3,900	D
5317	Lloyd F. Cook	South Fork Eel River	SE	SW	24	5S	3E	HM	0.15		D,Ir
5356	L. and Mary Grimmeison	Mad Creek	NW	SE	22	23N	16W	MD	0.05		Ir,D
6426	Neil G. Mackinnon, et al.	Big Dann Creek	NW	SE	12	23N	17W	MD		10,250	D,Ir
6835	Benbow Hotel Co.	South Fork Eel River	SE	SW	36	4S	3E	HM	130		P**
7238	Ellen I. Nehs	Squaw Creek	Lot 3		20	23N	16W	MD		1,500	D,R
7409	Heath Angelo	Elder Creek	SE	NE	29	22N	16W	MD		11,000	Ir,D
7473	Heath Angelo	Elder Creek	SE	NE	29	22N	16W	MD	0.68		P
7736	Division of Highways	Hinkle Spring	Lot 2		23	23N	16W	MD		1,000	R
8060	Einer Olson	Cedar Creek	NE	NE	14	23N	17W	MD		5,000	D
8152	Lanes Redwood Flat, Inc.	Dora Creek	SW	NW	28	24N	17W	MD	0.49		P,D
9382	Division of Highways	U* Spring	NW	SE	20	2S	3E	HD		5,000	R
9518	C. O. Mulock and O. and R. C. Miller	Big Dann Creek	SE	SW	12	23N	17W	MD		11,500	D

Appli-cation number	Name of applicant	Source	Location of point of diversion: ¼	¼	Sec-tion	Town-ship	Range	Merid-ian	Amount: Second-feet	Gallons per day	Purpose*
9686	Garberville Water Company, Inc.	South Fork Eel River	SW	SE	24	4S	3E	HD	0.155		Mu
9788	Division of Highways	U* Spring	NW-	SE	28	2S	3E	HD		970	R
10198	Earl V. Evans	U* Stream	NW	SE	9	4S	3E	HD		12,000	Ir,D
10542	Mast Lumber Co. Inc.	School House Creek	NE	NE	21	21N	15W	MD		86,400	D,Ir
11292	Ellen Ida Nehs	Squaw Creek	Lot 3		20	23N	16W	MD	0.184		P,D
11436	Department of Fish and Game	Cedar Creek	SW	SE	14	23N	17W	MD	12		D,H
11876	Redway Water Co.	South Fork Eel River	NE	SW	14	4S	3E	HD	0.223		Mu
12568	T. and M. Harrington	Butte Creek	NW	SE	10	3S	3E	HD		1,000	D
12798	Holton Hornbeck	Cedar Creek	SE	NE	14	23N	17W	MD		3,200	D
12848	Division of Beaches and Parks	Rock Creek	Lot 10		3	23N	17W	MD		10,000	D
12872	Division of Beaches and Parks	U* Stream	SE	SE	34	2S	3E	HM		7,500	D
13240	J. H. and R. R. Neblett	U* Spring	NW	NE	27	23N	16W	MD		6,500	D
13699	E. F. Steinmeyer	South Fork Eel River	SW	SE	8	19N	12W	MD	0.05		Ir
			NE	SE							
			NE	NE	17	19N	12W	MD	0.51		
13912	G. L. Jessup	Mill Creek	NW	SW	11	21N	15W	MD	0.25		Ir
13979	Holton Hornbeck	Cedar Creek	SE	NE	14	23N	17W	MD	0.11		In
14029	Warren L. Smith	U* Spring	SE	NW	4	3S	3E	HM	0.09		Ir
14076	Warren L. Smith	U* Stream	SE	NE	5	3S	3E	HM	0.03		Ir
14080	Meyers Water Works	Pete Creek	NW	SE	30	2S	3E	HD	0.446		Mu
14098	Division of Forestry	U* Spring	SE	NW	14	23N	17W	MD	0.005		D
14652	Division of Beaches and Parks	Durphy Creek	NE	SW	14	5S	3E	HM	0.046		D

Application number	Name of applicant	Source	Location of point of diversion: ¼	¼	Sec.	Township	Range	Meridian	Amount: Second-feet	Gallons per day	Purpose*
14691	Alice Hulse Kinsey	East Branch South Fork Eel River	Lot 6		4	5S	4E	HM	0.5		Ir
15036	Samuel Lee Griffin	Cedar Creek	NE	SE	14	23N	17W	MD		7,500	D
15694	Cyril and R. Flugger	U* Spring, Little Dann Creek	SW SE	SE NE	13	23N	17W	MD	0.13		D
15926	The Pacific Coast Company	Cedar Creek	SE	SE	11	23N	17W	MD	0.16		In,D,F
15949	Malcolm P. Johnston, et al.	Little Dann Creek	SE	NE	13	23N	17W	MD	0.031		D
16088	W. C. Johnston	Dutch Charlie Creek	SW	NW	9	21N	16W	MD	1		Ir
		Rock Creek	SW	NE	9	21N	16W	MD			
		South Fork Eel River	NW	SW	9	21N	16W	MD			
16608	Phillipsville Water Company	Anderson Creek	NW	NW	18	3S	4E	HM	0.09		Mu
16615	W. W. and V. V. Marshall	South Fork Eel River	NE	NW	24	4S	3E	HM	0.71		Ir,S
16788	P. M. and B. Schmoak	U* Stream	NE	NW	24	5S	4E	HM	0.044		D,Ir
17465	Oscar W. Johnson	U* Spring	NE	SW	16	2S	3E	HM		2,420	D,Ir,F
17807	Walter E. Fitch	Mill Creek	NE	SE	10	21N	15W	MD	0.72		Ir
17809	W. L. Frier	Cahto Creek	SW	NW	13	21N	15W	MD	1.25		Ir
18120	Charles C. Kirk	Big Spring	SE	NW	20	24N	16W	MD	0.5		Mi
18766	Charles C. Kirk								0.08		
18702	George S. and Helen Daniels	Mud Spring Creek, Tributary Ten Mile Creek							2.22	47 acre-feet storage	Ir,D

Application number	Name of applicant	Source	Location of point of diversion: ¼	¼	Section	Township	Range	Meridian	Amount: Second-feet	Gallons per day	Purpose*
19295	Sequoia Tree Farm	South Fork Eel River							0.2		Ir
19312	Russel C. and Lucille Webb	Feese Creek Tributary South Fork Eel River							0.036		D

* D domestic use
F fire protection use
H fish hatchery use
In industrial use
Ir irrigative use
Mi mining use
Mu municipal use
P power use
R recreation use
S stock use
U unnamed

** Power facilities not in active use at present time.

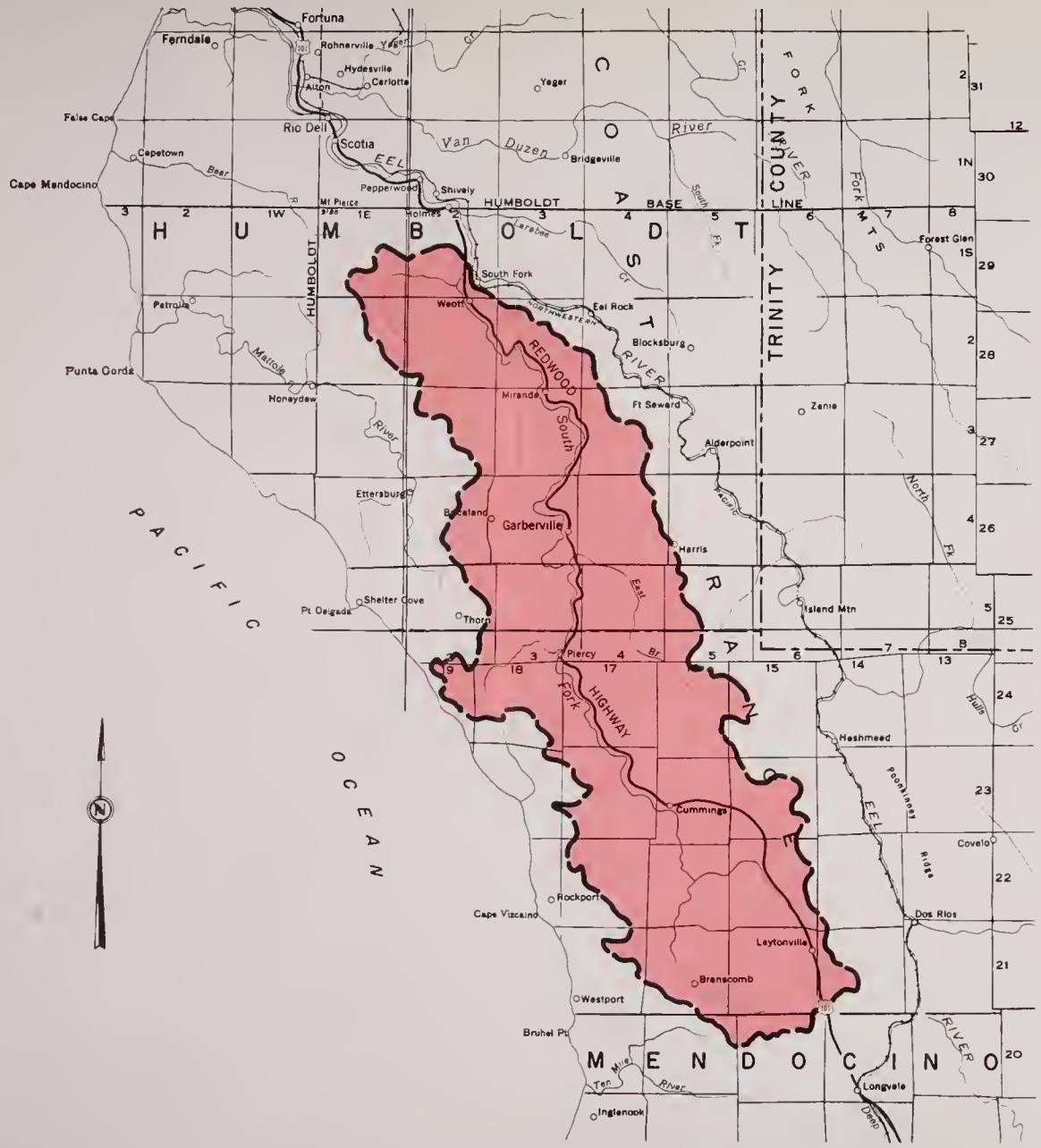
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
NORTHERN BRANCH
BRANSCOMB PROJECT INVESTIGATION

LOCATION OF SOUTH FORK EEL RIVER BASIN

1962

SCALE OF MILES

8 0 8



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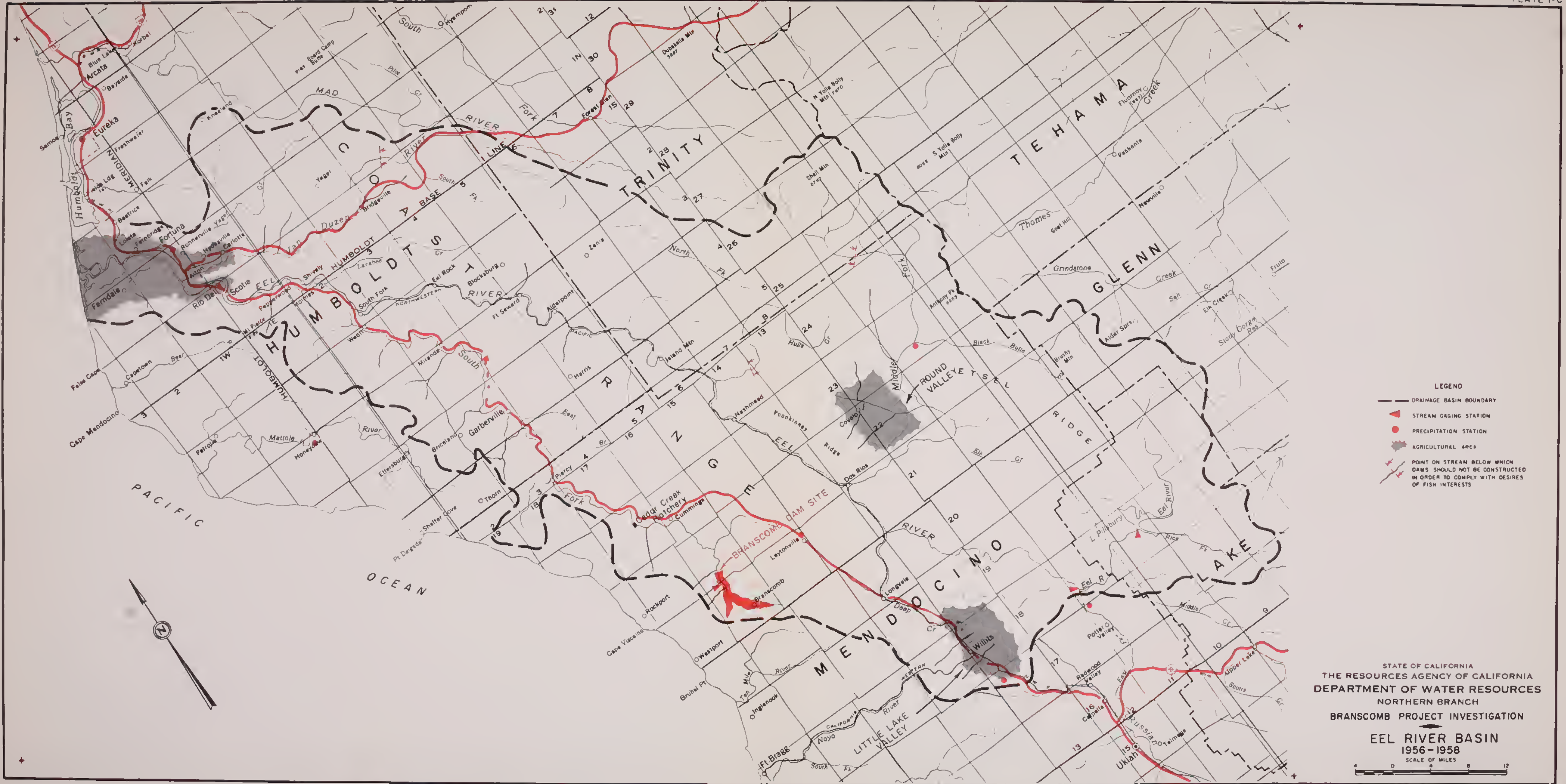

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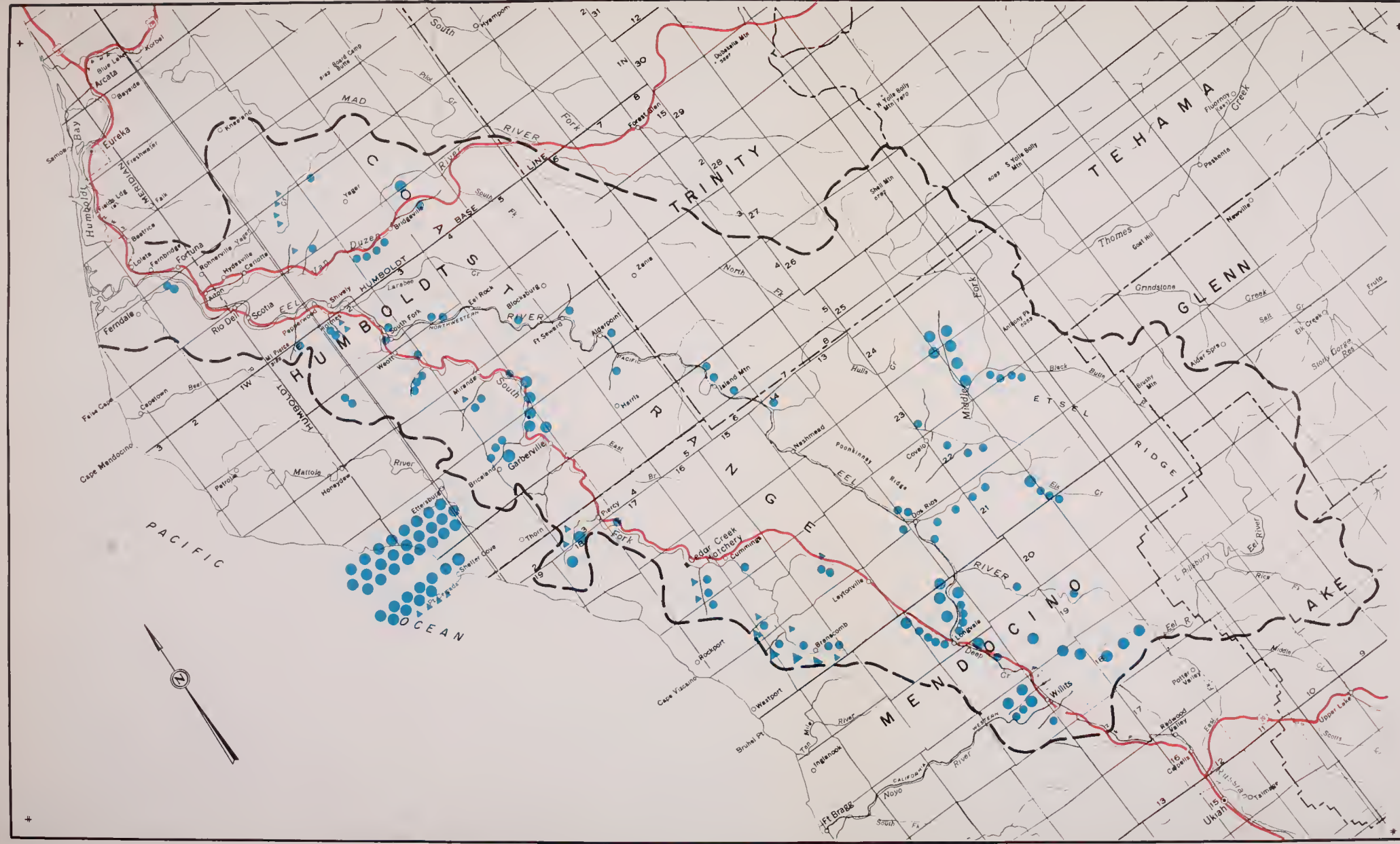
NORTHERN BRANCH
BRANSCOMB PROJECT INVESTIGATION

EEL RIVER BASIN
1956 - 1958

LAYTONVILLE
PHILLIPSVILLE
GARBERVILLE
BRIDGEVILLE
REDWAY
BRANSCOMB
LEGGETT VALLEY
PROPOSED BRANSCOMB RESERVOIR
SOUTH FORK
EEL
RIVER
HUMBOLDT COUNTY
MENDOCINO COUNTY
LEGEND
STREAM GAGING STATIONS
PRECIPITATION STATIONS
EQUAL MEAN ANNUAL PRECIPITATION IN INCHES (JULY 1,1905 THROUGH JUNE 30,1955)
DAM SITES CONSIDERED
POINT OF STREAM FLOW CONTROL
DRAINAGE BASIN BOUNDARY
SUBAREA BOUNDARY
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
NORTHERN BRANCH
BRANSCOMB PROJECT INVESTIGATION
SOUTH FORK EEL RIVER BASIN
SCALE OF MILES
1962



LEGEND

SPECIES	FISH COUNT 50	10
KING SALMON	●	▲
SILVER SALMON	●	▲

(DOES NOT INCLUDE DAM COUNTS)

DRAINAGE BASIN BOUNDARY

STATE OF CALIFORNIA
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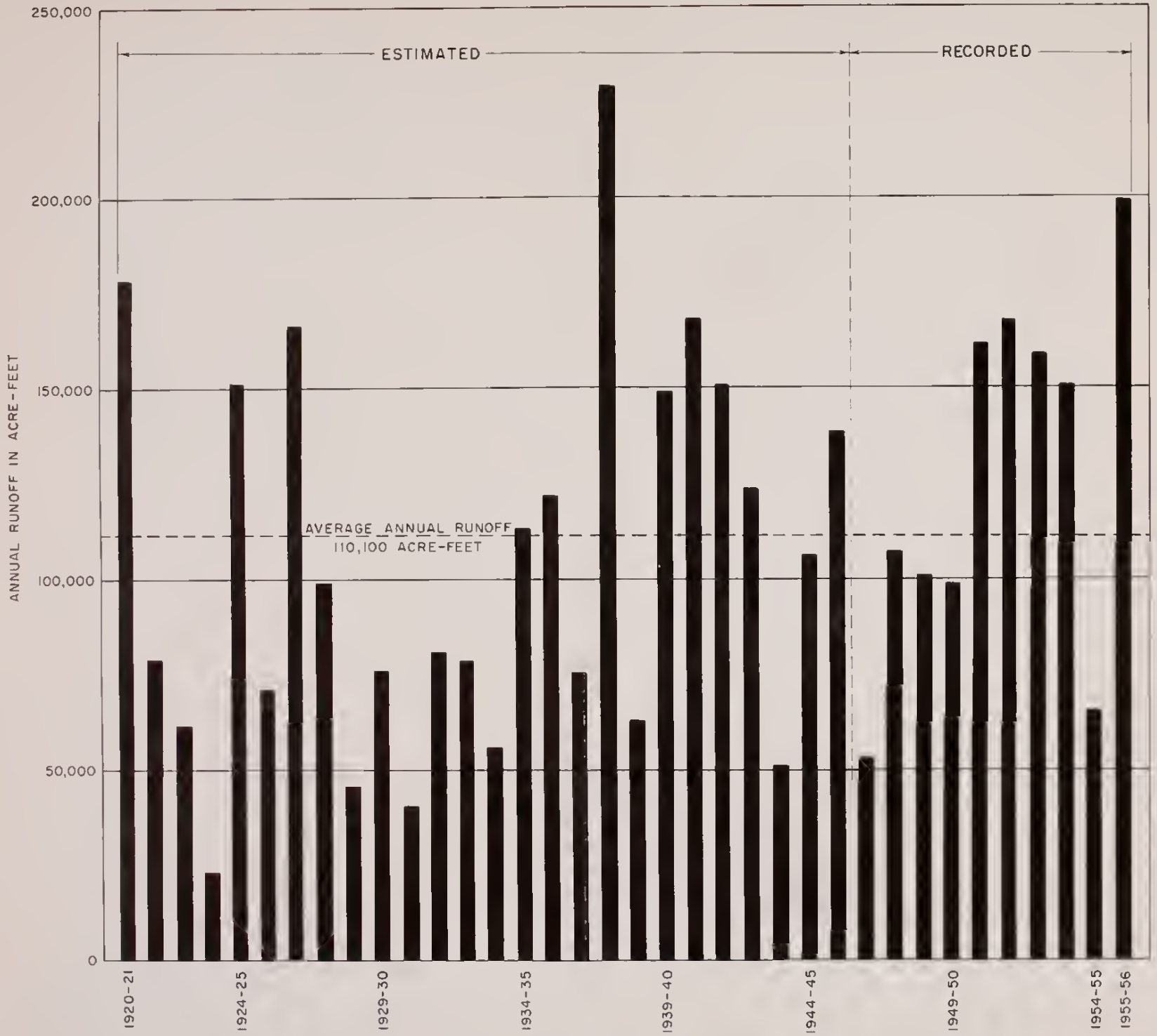
DEPARTMENT OF WATER RESOURCES
NORTHERN BRANCH

BRANSCOMB PROJECT INVESTIGATION

SALMON SPAWNING DISTRIBUTION 1956 – 1958

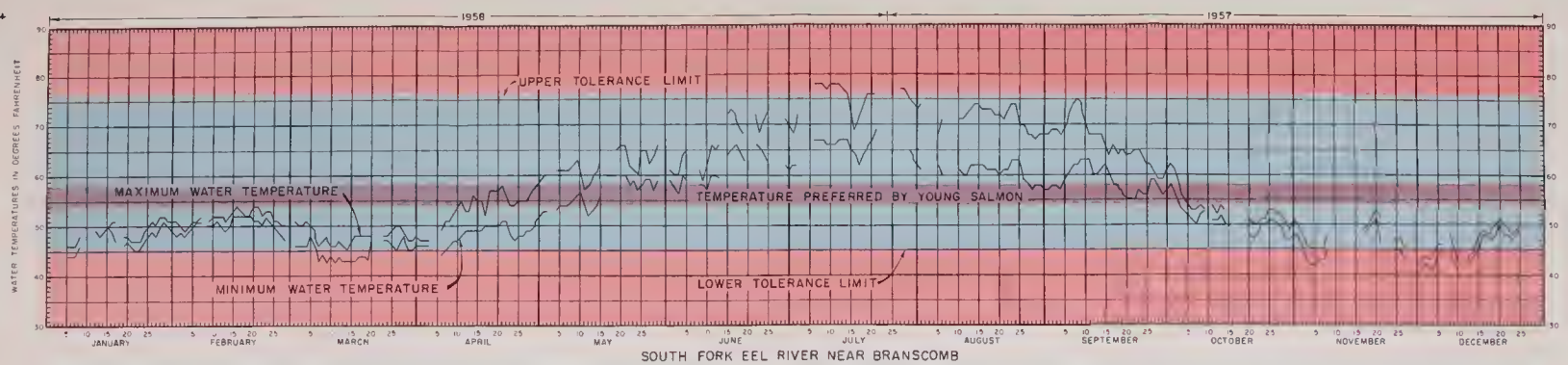
SCALE OF MILES
0 4 8 12



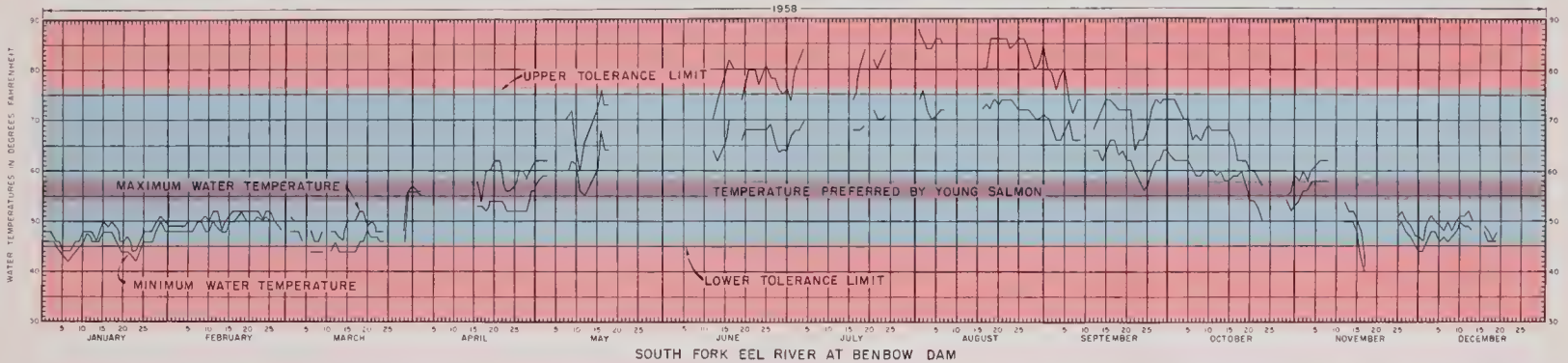
ANNUAL RUNOFF AT BRANSCOMB STREAM GAGING STATION, SOUTH FORK EEL RIVER

OCTOBER 1, 1920, THROUGH SEPTEMBER 30, 1956

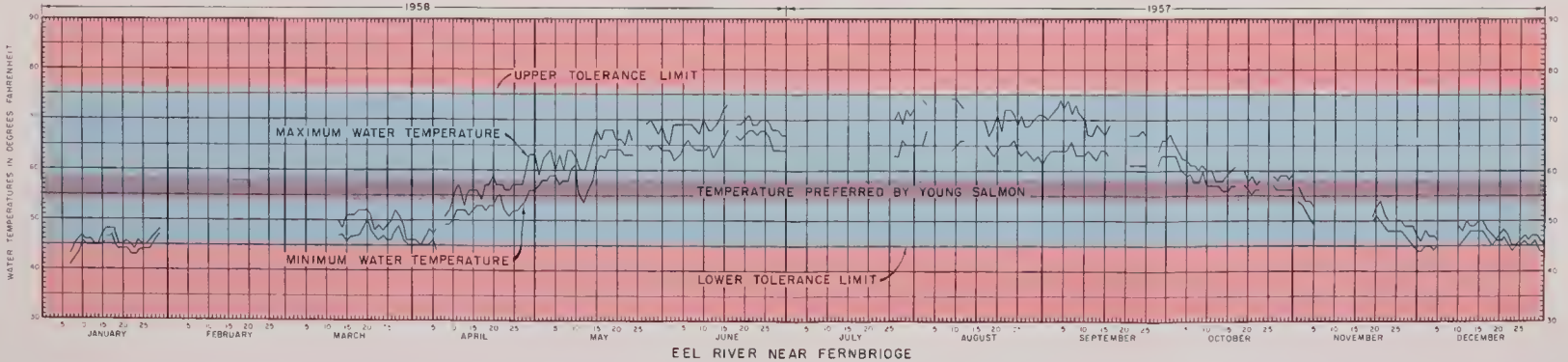
DEPARTMENT OF WATER RESOURCES 1962



SOUTH FORK EEL RIVER NEAR BRANSCOMB



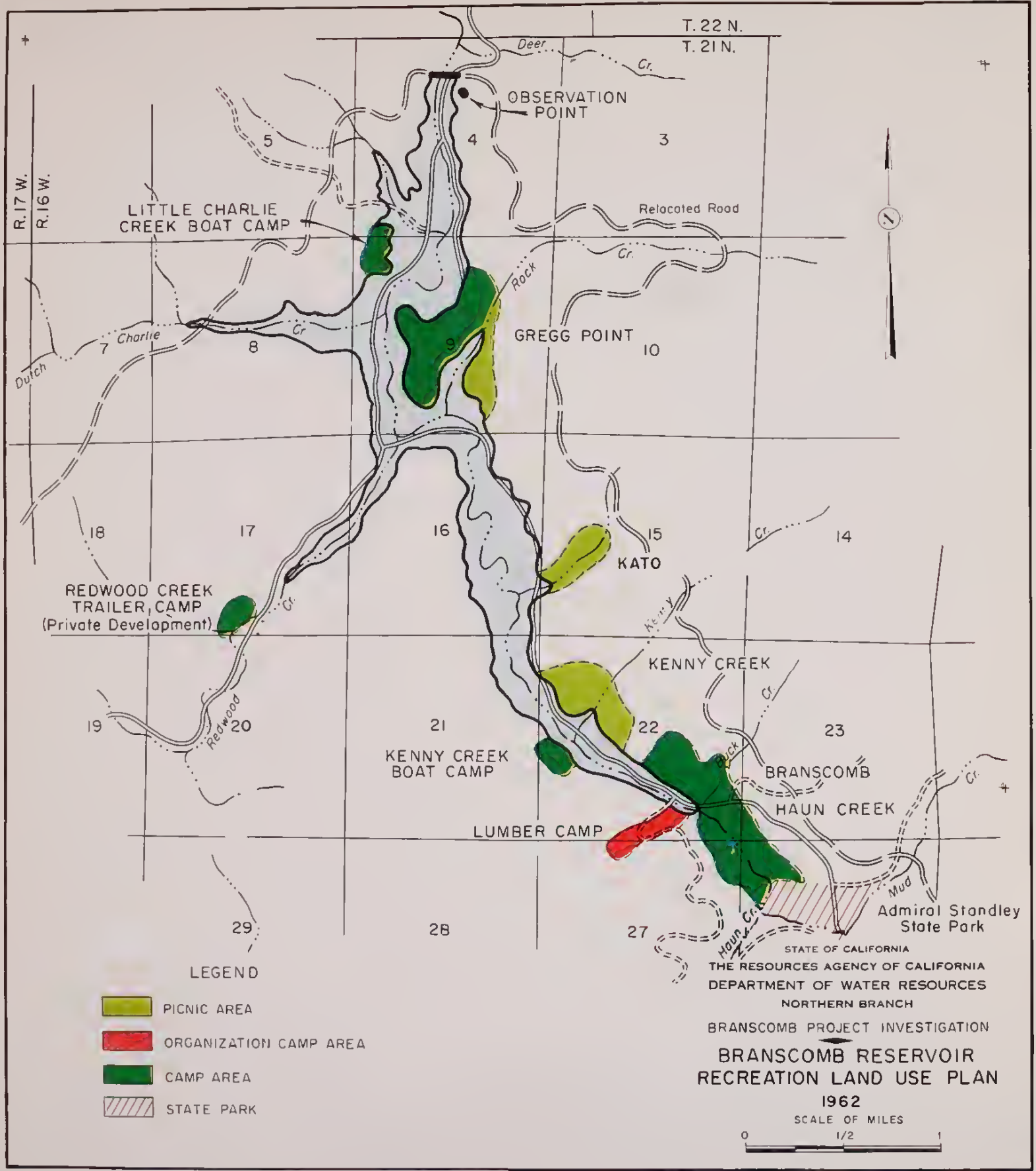
SOUTH FORK EEL RIVER AT BENBOW DAM

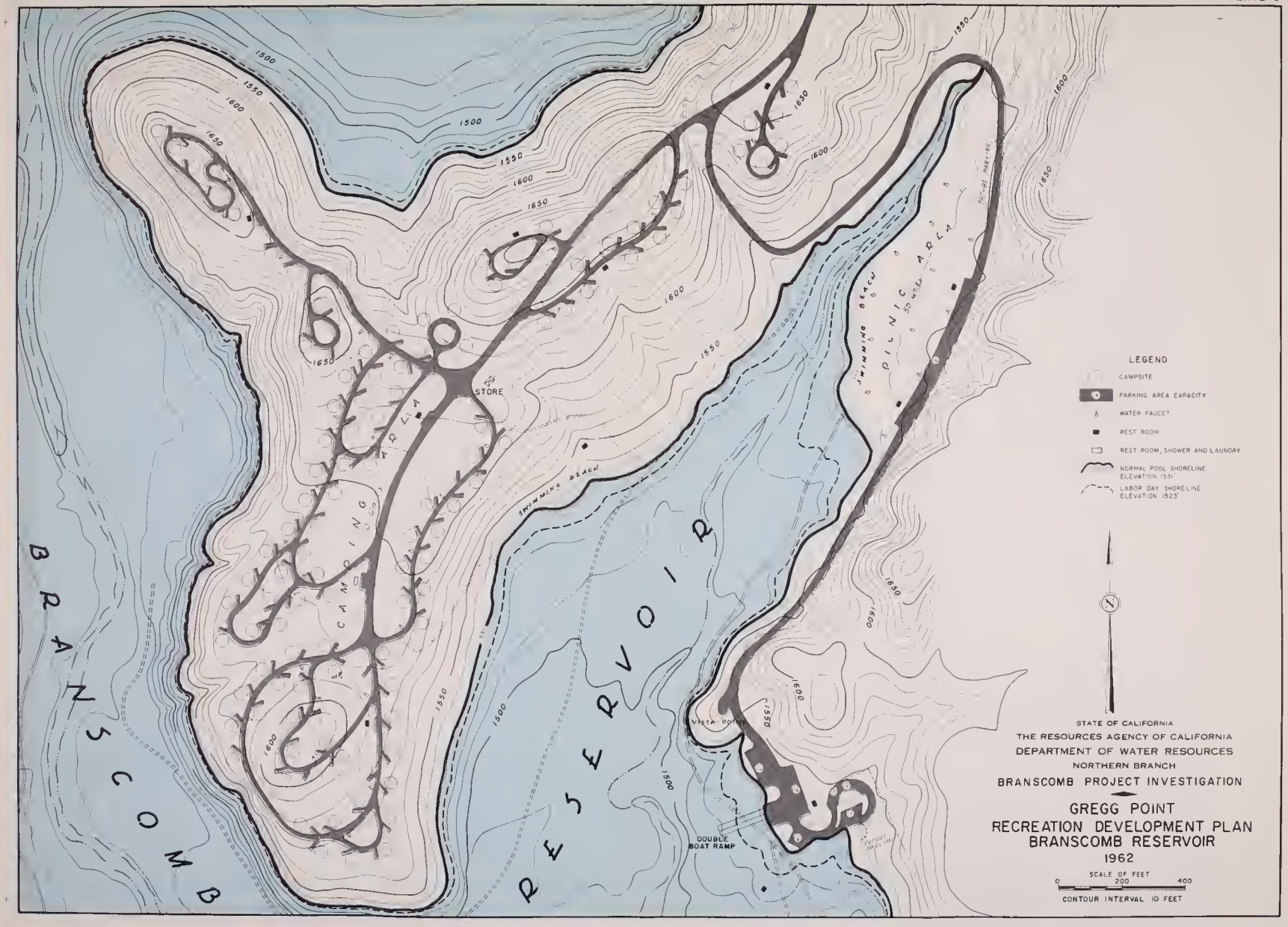


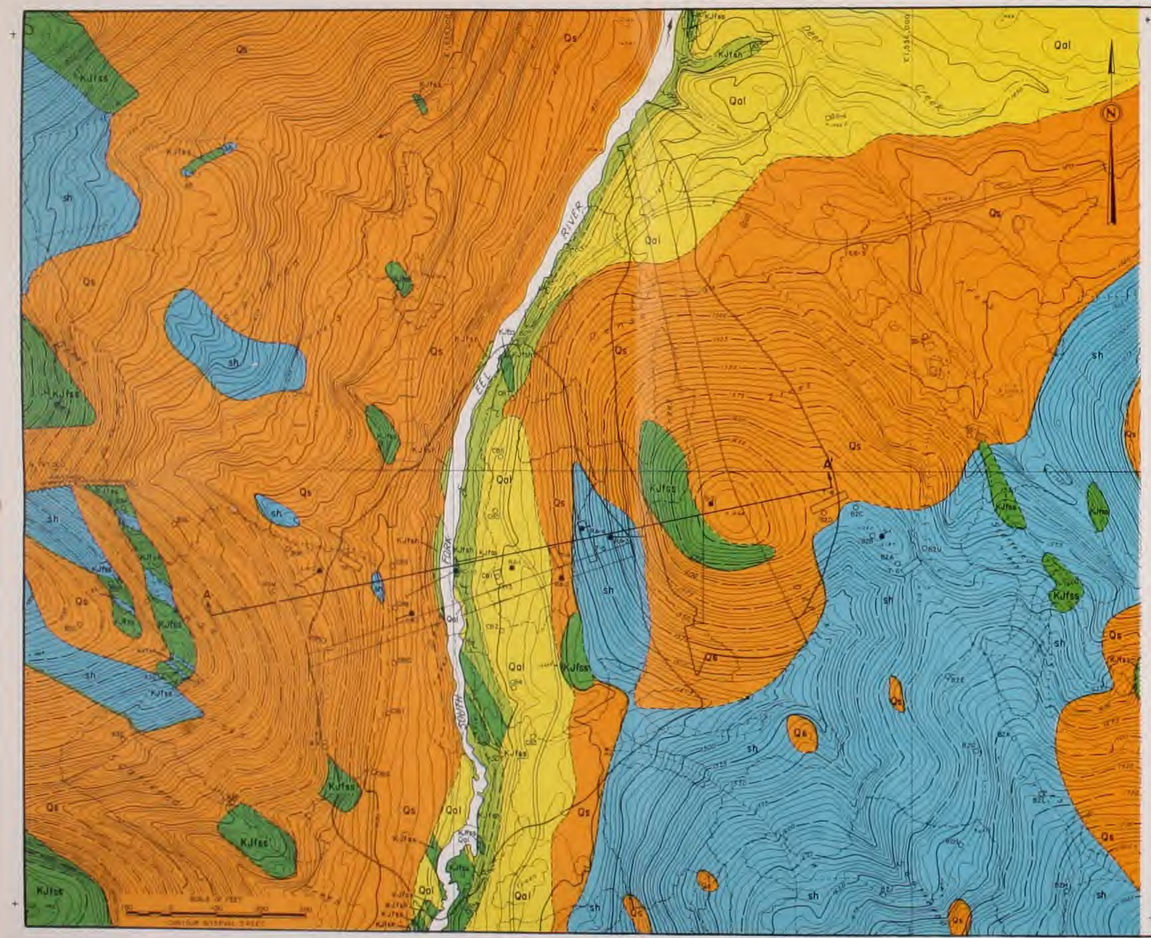
EEL RIVER NEAR FERNBRIDGE

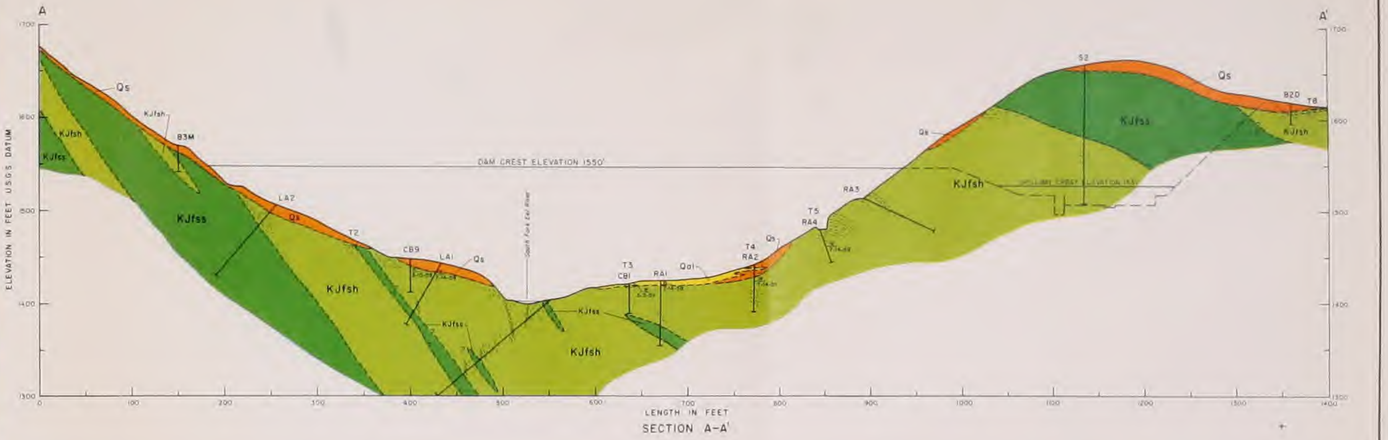
TEMPERATURE TOLERANCES OF YOUNG SALMON AND OBSERVED STREAM TEMPERATURES

DEPARTMENT OF WATER RESOURCES 1962


T. 22 N.
T. 21 N.
R. 17 W.
R. 16 W.
Deer Cr.
OBSERVATION POINT
LITTLE CHARLIE CREEK BOAT CAMP
Relocated Road
Rock Cr.
GREGG POINT
Dutch Charlie Cr.
REDWOOD CREEK TRAILER CAMP (Private Development)
KATO
Kenny Cr.
KENNY CREEK
KENNY CREEK BOAT CAMP
Redwood Cr.
Rock Cr.
BRANSCOMB
HAUN CREEK
LUMBER CAMP
Mud Cr.
Haun Cr.
Admiral Standley State Park
5
4
3
7
8
9
10
18
17
16
15
14
19
20
21
22
23
29
28
27
LEGEND
PICNIC AREA
ORGANIZATION CAMP AREA
CAMP AREA
STATE PARK
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
NORTHERN BRANCH
BRANSCOMB PROJECT INVESTIGATION
BRANSCOMB RESERVOIR
RECREATION LAND USE PLAN
1962
SCALE OF MILES
0
1/2
1


BRANSCOMB
RESERVOIR
CAMPING AREA
STORE
SWIMMING BEACH
PICNIC AREA
SWIMMING BEACH
VISTA POINT
DOUBLE BOAT RAMP
1500
1550
1600
1650
LEGEND
CAMPSITE
PARKING AREA CAPACITY
WATER FAUCET
REST ROOM
REST ROOM, SHOWER AND LAUNDRY
NORMAL POOL SHORELINE ELEVATION 1531'
LABOR DAY SHORELINE ELEVATION 1523'
N
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
NORTHERN BRANCH
BRANSCOMB PROJECT INVESTIGATION
GREGG POINT
RECREATION DEVELOPMENT PLAN
BRANSCOMB RESERVOIR
1962
SCALE OF FEET
0 200 400
CONTOUR INTERVAL 10 FEET





LEGEND

KJfss SANDSTONE
POORLY SORTED, FINE- TO MEDIUM GRAINED AND CONTAINING OC-CASIONAL PEBBLY INTERVALS. COMPOSED OF ROCK FRAGMENTS, FELDSPAR, AND FERROMAGNESIAN MINERALS BOUND TOGETHER IN AN ARGILLACEOUS MATRIX. GREEN, HARD AND TOUGH WHERE UN-WEATHERED; LIGHT BROWN, SOFT, AND FRIABLE WHERE WEATH-ERED. PERMEABLE DUE TO OPEN, INTERCONNECTED FRACTURES WHICH BECOME TIGHTER WITH INCREASING DEPTH.

KJfsh SHALE
FOUND UNDISTURBED ONLY IN STREAM CHANNEL AND IN DRILL HOLES; GENERALLY COMPOSED OF SILT AND CLAY SIZE PARTI-CLES TOO SMALL TO IDENTIFY. GREY TO BLACK, COMPARABLE-TY SEVERELY FRACTURED, PREFERRED DIRECTION OF FRACTUR-ING PARALLELS BEDDING OR LAMINATIONS. SLICKENSIDES PRE-SENT ON VIRTUALLY ALL FRACTURES, READILY SPLITS INTO THIN BRITTLE FLAKES.

sh SLUMPED SHALE
FOUND ONLY ON SLOPES AND HILLS. BEST DEVELOPED AREAS. FRACTURE PLANES ARE NEARLY NORMAL TO THE SLOPE OF THE HILL. LAMINATIONS VISIBLE BUT CURVED DOWNSLOPE BY SLOW MOVEMENT. FRACTURING EXTREME, SOFT, PLASTIC, CLAY FILL-ING FRACTURES BECOMES PROGRESSIVELY MORE ABUNDANT NEAR THE SURFACE. BROWN AND SOFTER THAN FRESH ROCK.

Qs COLLUVIUM
INCLUDES SANDSTONE TALUS, SOIL CREEP OR POSSIBLE LAND-SLIDE DEBRIS. COMPOSED OF ANGULAR WEATHERED FRAGMENTS OF SANDSTONE AND SHALE IN A SANDY CLAY MATRIX. THICKEST AT THE FOOT OF SLOPES AND ON HILLSIDES WHERE SHALE BED-DING AND PREFERRED DIRECTION OF FRACTURING NEARLY PARALLEL SLOPE.

Qal ALLUVIUM
ROUGHLY STRATIFIED FLOOD PLAIN AND STREAM CHANNEL DE-POSITS. COMPOSED OF WEATHERED, ROUNDED SANDSTONE BOULDERS IN A CLAYEY SAND MATRIX.

SYMBOLS

- FOUNDATION DRILL HOLE, VERTICAL
- FOUNDATION DRILL HOLE, INCLINED
- TRENCH
- AUGER SAMPLE LOCATION
- GROUND WATER LEVEL ON DATE INDICATED
- 3-25-59
- (?) INDICATES WATER LEVEL INFERRED FROM CONDITION OF ROCK
- VERTICALLY DIPPING BEDS
- STRIKE AND DIP OF BEDDING
- STRIKE AND DIP IN DISTURBED SHALE
- SHEAR ZONE
- CONTACT
- FAULTING
- GEOLOGIC SECTION
- SHALE BEDDING

(All based on California Coordinate System Zone 1)

STATE OF CALIFORNIA
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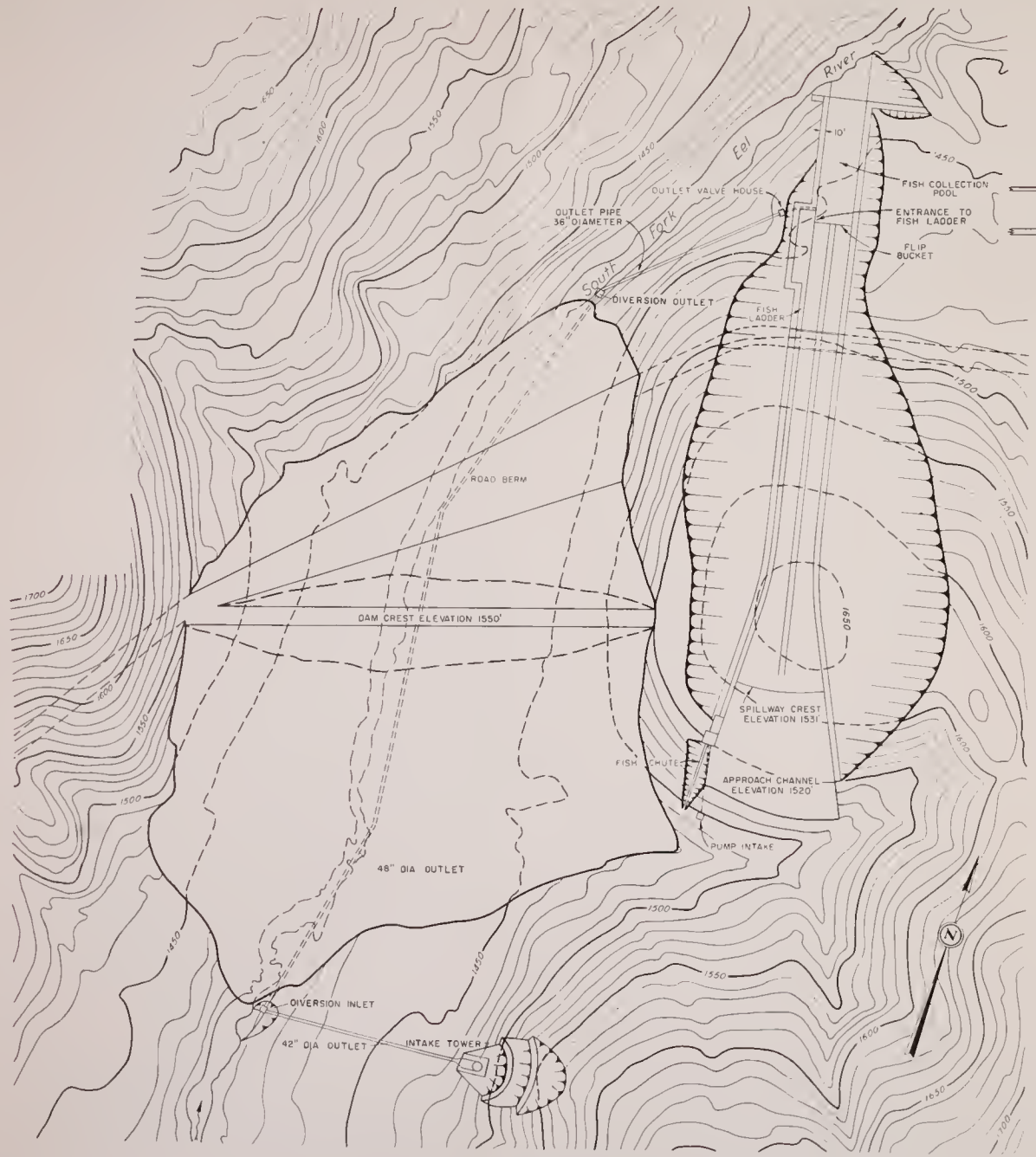
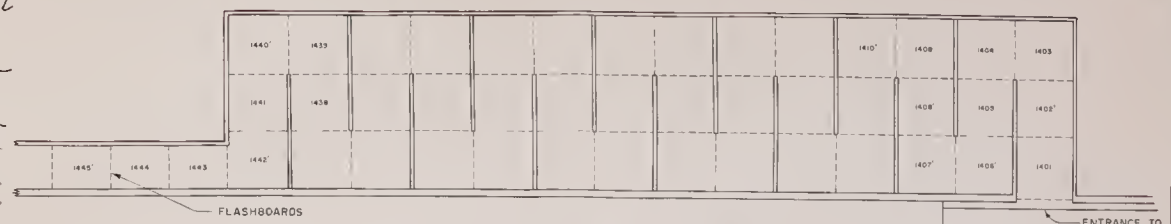
NORTHERN BRANCH
BRANSCOMB PROJECT INVESTIGATION

GEOLOGY OF BRANSCOMB DAM SITE
1962



GENERAL PLAN OF DAM

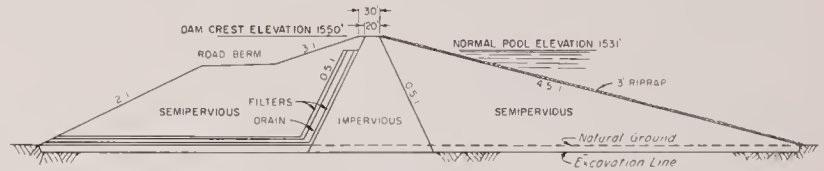
SCALE OF FEET 0 100 200



NOTE ELEVATIONS IN FISH LADDER ARE AT WATER SURFACE
MINIMUM DEPTH OF WATER IN POOLS IS 6 FEET

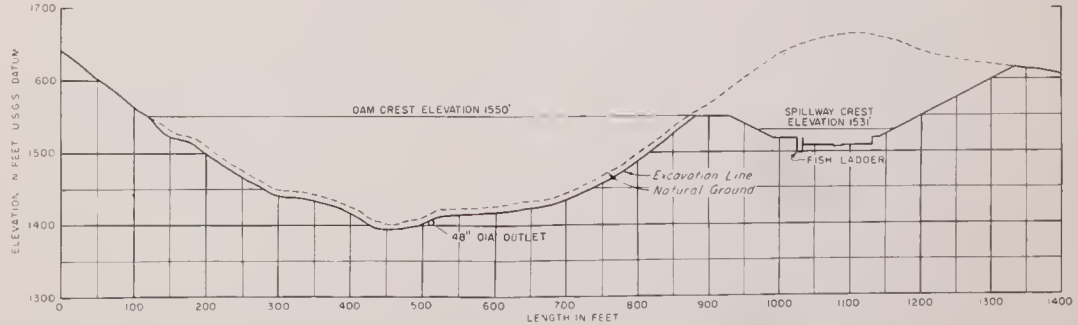
DETAIL OF BRANSCOMB FISH LADDER ENTRANCE PLAN

SCALE OF FEET 10 0 10 20



SECTION OF DAM

SCALE OF FEET 0 100 200



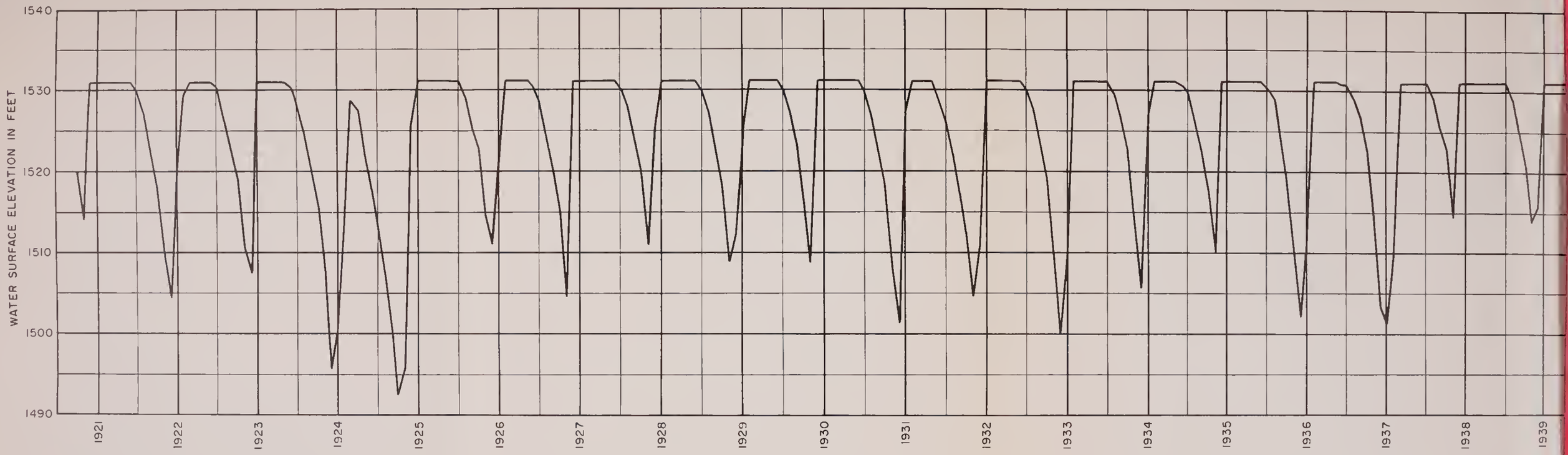
PROFILE OF DAM
LOOKING DOWNSTREAM

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF RESOURCES PLANNING

BRANSCOMB PROJECT INVESTIGATION

BRANSCOMB DAM, SOUTH FORK EEL RIVER

1960

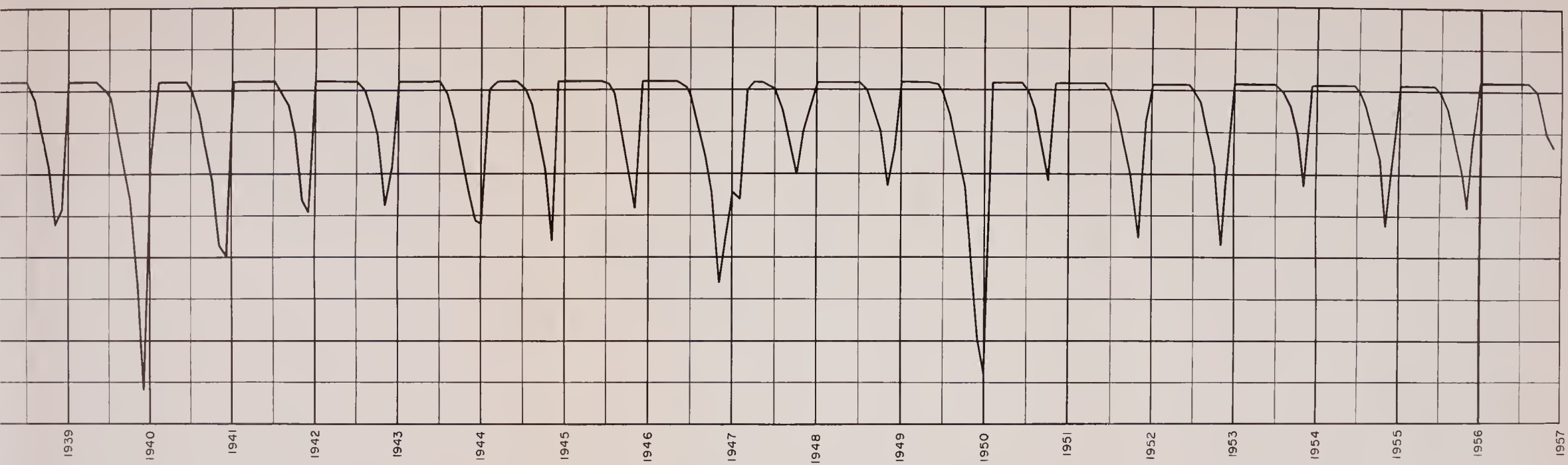


NOTE:

RESERVOIR WATER SURFACE ELEVATION FLUCTUATION, JUNE 1 THROUGH AUGUST 31
36-YEAR BASE RUNOFF PERIOD: AVERAGE: 7.7 FEET; MINIMUM: 3 FEET; MAXIMUM:

ANNUAL RESERVOIR WATER SURFACE ELEVATION FLUCTUATION THROUGHOUT THE 3
RUNOFF PERIOD: AVERAGE 22.2 FEET; MINIMUM: 11 FEET; MAXIMUM: 37 FEET

DEPARTMENT OF WATER RESOURCES 1962



H AUGUST 31, THROUGHOUT THE
T; MAXIMUM 27 FEET

UGHOUT THE 36-YEAR BASE
7 FEET

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF RESOURCES PLANNING
BRANSCOMB PROJECT INVESTIGATION

BRANSCOMB RESERVOIR OPERATION
FLUCTUATION OF WATER SURFACE ELEVATION
OCTOBER 1, 1920, THROUGH SEPTEMBER 30, 1956